# Enhancing Early Language Development in Children with Intellectual Disabilities

Margje van der Schuit

**General Acknowledgements**

This research was part of the research program 'In-Com-Clusie: Inclusion through the development and support of communication' (2004-2008) and is funded by the European Union, Interreg 4-BMG-V-1=31, Fund Nuts-Ohra, Royal Kentalis, and Radar.

Special appreciation is given to the children and parents who participated in the study, and the clinical experts from the participating day-care centers and schools.

Cover design by: NIKA Grafische vormgeving Vught

Published by: EAC, Research Centre on Atypical Communication, Radboud University Nijmegen

Printed by: Ipskamp Drukkers B.V.

ISBN/EAN: 978-90-9026325-0

# Enhancing Early Language Development in Children with Intellectual Disabilities

Een wetenschappelijke proeve op het gebied van de
Sociale Wetenschappen

Proefschrift

ter verkrijging van de graad van doctor
aan de Radboud Universiteit Nijmegen
op gezag van de rector magnificus prof. mr. S.C.J.J. Kortmann,
volgens besluit van het college van decanen
in het openbaar te verdedigen op woensdag 26 oktober 2011
om 15.30 uur precies

door


Margje van der Schuit
geboren op 4 april 1982
te Wageningen

| | |
|---|---|
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“Binnen de beperkingen zijn de mogelijkheden eindeloos!”

*Jules Deelder*

*Voor mijn ouders*

*Voor Raymond*

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# Voorwoord

Het is af! Vijf jaar van mijn werkende leven samengevat in dit proefschrift. Ondanks dat er slechts één naam op de voorkant staat, schrijf je een proefschrift nooit alleen.

Allereerst mijn grote dank voor alle kinderen, ouders, kinderdagcentra en scholen die hebben deelgenomen aan het onderzoek. Zonder hen was er überhaupt geen proefschrift geweest. In het bijzonder een bedankje voor het team van KDC de Grummelkes, waarvan met name Leonie en Nicolle de drijvende krachten achter het KLIN*c*-Atelier waren.

Tijdens mijn promotie had ik drie begeleiders, die ieder op hun eigen manier belangrijk zijn geweest voor dit proefschrift. Ludo Verhoeven, bedankt dat je mij de kans hebt gegeven om dit promotieonderzoek uit te voeren. De weg naar dit proefschrift was niet altijd makkelijk, maar jij wist altijd hoe we verder moesten. Na een overleg met jou had ik weer de motivatie en het vertrouwen om door te gaan. Wanneer deze gesprekken op een vrijdagmiddag plaatsvonden, zorgde dit regelmatig voor een weekendje thuiswerken.

Hans van Balkom, naast aan alle werkoverleggen denk ik ook met veel plezier terug aan de verschillende congressen die we hebben bezocht. Je had altijd heel wat te stellen met mij in het vliegtuig te krijgen, maar jouw geruststellende woorden ('Als we neerstorten moest het zo zijn…') waren over het algemeen een grote steun. Onze vlucht terug naar huis uit Philadelphia zal ik niet snel vergeten, net als het bezoekje aan het concertgebouw in Pittsburgh waarvan het balkon toch wel erg hoog is!

Eliane Segers, heel wat werkgerelateerde overleggen hebben bij jou thuis in Eindhoven of in de auto naar Nijmegen plaatsgevonden. Heel erg bedankt voor het veelvuldig lezen van mijn stukken. Fijn ook dat je altijd een kritische blik hebt gehouden! Hoewel soms confronterend hielden jouw vragen en opmerkingen mij scherp en zorgden ervoor dat ik steeds bleef reflecteren op mijn eigen werk.

Gedurende mijn onderzoek ben ik geholpen door verschillende studenten, Anke, Carla, Lotte, Marieke, Miranda en Noor. Jullie hebben het zwaar gehad met het reizen naar afgelegen oorden als Cadier en Keer en Landgraaf, zeker met al die testkoffers. Jitske de Haan, jij hebt na je studie een tijd geholpen met het testen, heel erg bedankt hiervoor!

Dan mijn paranimfen, Marlies de Zeeuw en Nina Wolters. Alvast bedankt voor jullie steun tijdens de verdediging zelf, maar niet minder bedankt voor alle steun de afgelopen jaren! Marlies, als kamergenoten hebben we heel wat afgekletst. Het was soms zo erg dat we 's ochtends bij binnenkomst begonnen met praten bij het eerste kopje thee en rond 12 uur bedachten dat we dan net zo goed maar door konden gaan tijdens de lunchpauze. Ondanks, of misschien wel met dank aan deze momenten is mijn proefschrift toch nog op tijd afgekomen. Nina, als buurvrouw kwam je regelmatig even buurten. Soms waren de gesprekken werktechnisch van aard, even zo vaak werd het weekend doorgenomen. En wanneer we niet op de universiteit aanwezig waren werden (en worden) deze gesprekken via de e-mail of sms gevoerd.

Andere collega's van de OLO-afdeling bedankt voor de gezellige lunches, borrels en uitjes. Alle mede-AiO's bedankt voor de momenten van herkenning en gedeelde frustraties wat betreft het promoveren. Dank ook voor de dames van het secretariaat, altijd geïnteresseerd en behulpzaam. Ik zal jullie schaterlachen waarvan het geluid regelmatig onze kamer haalde, gaan missen!

Judith Stoep, Hans Luiken en Judith Snieders, bedankt voor de prettige samenwerking tijdens de jaren van het KLIN*c*-Atelier. Het was een hectisch project, maar we hebben het gered! Marieke Peeters, onze projecten waren verbonden binnen In-Com-Clusie. Hierdoor hebben we veel samengewerkt, maar het ook buiten het werk gezellig gehad. Ik denk daarbij vooral met veel plezier terug aan de ISAAC-congressen die we samen hebben bezocht.

Een woord van dank ook voor alle lieve vrienden en vriendinnen, die altijd geïnteresseerd waren in mijn project en waarvan verschillenden het genot van promoveren ook zelf hebben ervaren of nog ervaren. Een speciaal dankjewel voor 'de meiden', Iris, Maaike en Suzanne. Zonder de zoveel-maandelijkse meiden-relax-dagen weet ik niet of ik in een dergelijke toestand de eindstreep had gehaald. Suzanne, bedankt dat je zo heerlijk nuchter en relativerend bent. Maaike, je weet wat een toestand het soms kan zijn, maar ook dat het altijd weer goed komt! En Iris, ook na ruim 29 jaar vriendschap zijn we nog niet uitgepraat, dus laten we het nog even voortzetten.

Mijn broertje Hidde, waarschijnlijk besef je zelf niet dat je wellicht één van de belangrijkste personen bent in dit dankwoord, want mede door jou ben ik me gaan interesseren voor het werk als orthopedagoog. En verder ben je ook gewoon een te gekke, stoere broer! Pap en mam, bedankt voor de kansen die jullie mij gegeven hebben, zowel via nature als nurture. Jullie vertrouwen in mij geeft mij het duwtje dat ik soms nodig heb.

De laatste woorden van dank zijn voor mijn man Raymond. Je was er bij problemen van technologische aard, maar even zo vaak was je er voor me bij problemen van meer emotionele aard. En in beide gevallen heb je heel wat met me te stellen gehad. Dit proefschrift had ik zeker niet kunnen schrijven zonder jouw steun en onvoorwaardelijk vertrouwen. Zoals al eens eerder gezegd, het blijft fijn om samen thuis te komen!

# Introduction

*Chapter 1*

For most children, the process of language development enfolds more or less automatically. The complexity of this process, however, becomes apparent at the moment a child faces developmental disabilities (e.g., intellectual, physical, sensory). Many children with intellectual disabilities (ID) experience difficulties in speech and language development (Kaiser, Hester, & McDuffie, 2001). And although language and literacy skills are considered to be important for a child's success in school and for being able to become independent in today's society, limited attention is given to the development of these skills in children with ID. Often, the priority of this process competes with the priority that has to be given to medical, physical, and behavioral problems. This is quite worrisome, because much of the problem behaviors these children show, stem from difficulties in the acquisition of language and communication skills (Sigafoos, Arthur, & O'Reilly, 2003; Wacker, Berg, & Harding, 2002). It seems that in many cases, valuable opportunities for stimulating the early language and communication development of these children are missed in the first 4 till 5 years of life, which can be seen as the most important period for the language development of children (Elman et al., 1996).

In this perspective, I focused on the dynamics of language acquisition of children with ID. Although it is a well-known fact that children with ID experience delays in language development (Kaiser et al., 2001; Rondal, 2001), varying language levels and atypical developmental trajectories in children with ID raise the question of how these children acquire language skills, and what role different levels of intelligence and other cognitive factors play in this development. Although the importance of the communicative environment for a child's language development is widely acknowledged (Hart & Risley, 1995; Whitehurst & Lonigan, 1998), little is known about these environments and the characteristics of language input for children with ID. Even less is known about the best ways to adjust these children's environment by means of an early intervention, in order to enhance their language development.

This introductory chapter will start with a description of language development in typically developing children. Next, the classification of intellectual disabilities will be considered, followed by a description of the International Classification of Function, Disability, and Health model, which provides a framework for studying the language acquisition in children with ID. In addition, as children acquire language in interaction with their communicative environment (e.g., parents, caregivers, teachers), these environments are also considered. This chapter ends with the research questions and the design of the present study and an outline of the studies presented in this thesis.

## Children with intellectual disabilities

The American Association on Intellectual and Developmental Disabilities [AAIDD] (2009) defines an intellectual disability as:

> "Intellectual disability is a disability characterized by significant limitations both in intellectual functioning and in adaptive behavior, which covers many everyday social and practical skills. This disability originates before the age of 18."

Intellectual functioning is often determined with standardized, intelligence tests that assess skills like reasoning and problem solving. An IQ score of 70-75 or lower is considered to indicate a limitation in intellectual functioning. However, when determining intellectual disabilities, it is important to not only assess IQ level, but also determine the level of adaptive behavior, which comprises three types of skills (AAIDD, 2010). First, conceptual skills like language, literacy, and concepts of time or numbers. Secondly, social skills, including the ability to understand and follow rules or obey laws, interpersonal skills, and social problem solving. And third, practical skills like functional daily living activities, the ability to use money or telephone, and occupational skills. Furthermore, in determining intellectual disabilities the child's environment needs to be taken into consideration. Both linguistic and cultural diversity should be assessed, because they influence the way someone communicates, moves, and behaves. It should be recognized that both weaknesses and strengths occur in one person, and that the level of functioning of a person can be improved with the right support.

The prevalence of ID in the Netherlands is around 7 per 1000 live births (0.7%) (Wullink, van Schrojenstein Lantman-de Valk, Dinant, & Metsemakers, 2007). Moderate and severe intellectual disabilities (IQ < 50) are less prevalent than mild intellectual disabilities (IQ between 50-70), which comprises about 75% of the cases. The intellectual disabilities can have several causes. However, in about 30 to 50% of the cases, the etiology cannot be identified (AAIDD, 2009). This is more often the case in individuals with mild ID than in individuals with IQ's below 50. Also, these individuals are more likely to be of a low socioeconomic status and to come from families with a higher prevalence of low intelligence levels. The more severe the intellectual disabilities, the more often an organic cause can be identified. These causes can have different times of onset, and are grouped in prenatal, perinatal, and postnatal causes (Daily, Hardinger, & Holmes, 2000; AAIDD, 2010). Prenatal causes include genetic defects, maternal infections (e.g., rubella, toxoplasmosis), and toxins ingested by the mother (e.g., fetal alcohol syndrome). Perinatal factors include problems that occur during birth, like prematurity and deprivation of oxygen (anoxia). Causes that occur postnatal are traumatic brain injury and illnesses like meningitis. For about one quarter of the cases of ID, a chromosomal abnormality can be identified (Daily et al., 2000). These include syndromes like Down syndrome, Velo-cardio-facial syndrome, Fragile X syndrome, and Williams syndrome. Co-morbidity with other conditions is high in individuals with ID. These can include autism spectrum disorders, attention deficit hyperactivity disorder, epilepsy, physical or sensory impairments, dyspraxia, and behavioral problems.

*The ICF-CY model*

The World Health Organization (WHO) has developed the International Classification of Functioning, Disability, and Health (ICF) model to describe the components of health (WHO, 2001). This ICF model (see Figure 1) reflects the current opinion that there are interactive relationships between a person's health condition and contextual factors (i.e., environmental and personal factors). The aim of the model is to provide a framework and a common language to describe health and health-related conditions, in order to improve communication between different disciplines and to enable the comparison of data across disciplines and countries. It can be used as a classification tool in several settings, like clinical practice and education, but also as a framework for social policy and research. For children and youth, an extension of the ICF model has recently been developed: the ICF-CY model (WHO, 2007). This was needed, as disabilities often show a different profile in children than in adults. The model therefore has to be more sensitive for developmental changes in children and youth, and should include the characteristics and environments of the different age groups (Lollar & Simeonsson, 2005).

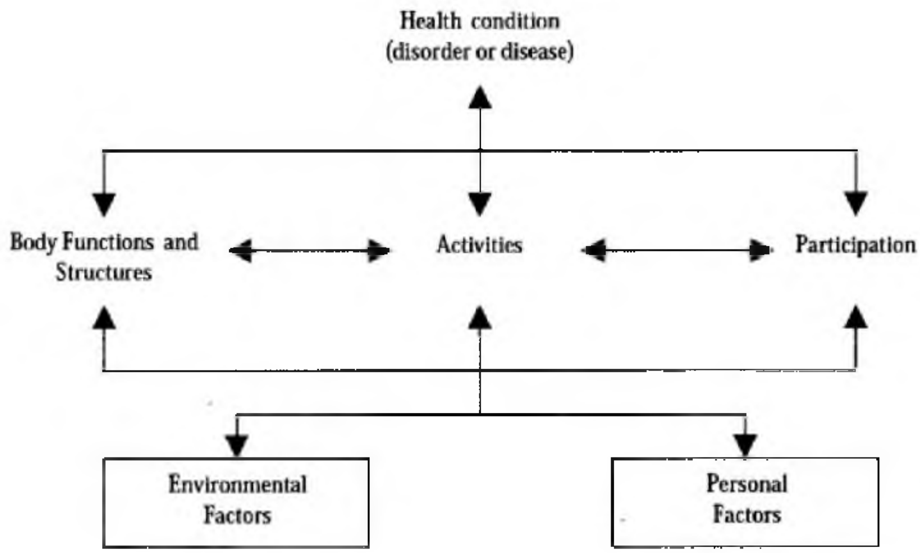


*Figure 1.* The ICF Model of human functioning and disability (WHO, 2001).

The ICF model consists of two parts; 1) *functioning and disability*, and 2) *contextual factors* (WHO, 2001). The first part comprises body functions and structures, activity, and participation. *Body functions* are described as the physiological functions of body systems (e.g., psychological functions or speech functions), and *body structures* are defined as anatomical parts of the body like organs and limbs. *Activity* is described as the execution of a task or action by the individual, and *participation* as the involvement in life situations. The second part of the model, contextual factors, comprises environmental factors and personal factors. *Environmental factors* are the physical, social and attitudinal environment in which individuals live and conduct their lives (e.g., home and school environment). *Personal factors* are the particular background of a person's life, and include features of the individual that are not part of the health condition (e.g., age, gender).

When studying the language development of children with ID, the different components of the ICF model need to be taken into account (WHO, 2007). This means that the *activity* language is performed by children with ID and that difficulties within this domain can be a result from disabilities in the *body structure and functions* of the child. These disabilities can include impairments in cognitive functioning, such as nonverbal intelligence and working memory, but also other impairments like visual and hearing impairments, speech impairments, and attention deficits. Language difficulties of children with ID will influence their *participation* in several situations, as it will hinder their ability to communicate with others and will have great influence on their academic success. The ICF model further stresses the importance of including *environmental factors* when investigating children's language abilities. Communicative environments of children include both home and school environments, which both can have a stimulating or restrictive effect on children's language development.

## Language acquisition in children with intellectual disabilities

*Basic principles of language acquisition*

Recent studies of neurocognition have revealed three essential components for the processing and learning of language: a memory component which provides a basis for the storage and retrieval of lexical information (e.g., vocabulary); a unification component which is responsible for the unification (merging, further syntactic processing) of lexically retrieved information (e.g., syntax); and a control component which relates language to action (e.g., cognitive control like working memory) (Hagoort, 2005). Behavioral research of the language development of typically developing children also shows this tripartite structure. Language learning requires from children a certain amount of cognitive control, and for language acquisition working memory has been found to be of crucial importance (Baddeley, 1986; Ellis & Sinclair, 1996). Working memory (WM) consists of three systems, namely the central executive, which serves as an attentional controller, and two separate systems for short-term storage of visuospatial and phonological information (i.e., the visuospatial sketchpad and the phonological loop). The phonological loop, in which phonological information can be stored and rehearsed for a short period of time, has been found to be the most important system of WM for language learning (Baddeley, 1986; Baddeley, Gathercole, & Papagno, 1998; Conway & Pisoni, 2008).

As a second cognitive ability, children need to learn that the speech streams they hear represent certain objects and actions. Around the age of 18 months, an important shift in children's cognitive development is visible, in that they start to realize that each object belongs to a category and that they show the emergence of exhaustive categorization (i.e., separately grouping of objects belonging to different categories) (Gopnik & Meltzoff, 1987, 1992; Mandler, 2004). The realization that objects can be categorized and that different objects and events each have their own *label*, is also associated with an increase in the rate with which new words are learned (Fenson et al., 1994). Productive vocabulary develops slowly at first but, around the age of 18 months, a child's vocabulary of about 50 words grows rapidly in what is sometimes called a 'vocabulary burst', with children adding up to about 7 new words per day to their vocabularies (Fenson et al., 1994).

At about the same time of this ‘vocabulary burst’, while children are continuing to add new words to their vocabulary, the first word combinations also appear, suggesting a causal relation between vocabulary development and the onset of grammatical development. According to the ‘critical mass hypothesis’, it is suggested that children need a certain level of lexical development in order to have syntactic development initiated (Bates & Goodman, 1997; Marchman & Bates, 1994). The development of syntax has indeed been found to begin at the time children actively use a minimum of 50 to 100 words. Children’s first syntactical knowledge is organized around specific words, early gesture-word combinations, and formulaic phrases or so-called templates, from which children start to abstract more general patterns to then be applied to new words and meanings, and start to produce multi-word utterances and/or multi-sign/symbol sequences (Akhtar, 1999; Lieven, Pine, & Baldwin, 1997; Tomasello, 2003).

The development of vocabulary and syntax are thus highly interdependent during early language development (Dionne, Dale, Boivin, & Plomin, 2003). During the earliest stages of language development, grammatical development is predicted by lexical development; a phenomenon known as lexical bootstrapping (Gleitman, 1990). Until 2;6 years of age, this lexical bootstrapping can be observed (Bates & Goodman, 1997; Marchman & Bates, 1994). After that, syntactic bootstrapping takes place, with syntactic knowledge facilitating lexical development (Jones Moyle, Ellis Weismer, Evans, & Lindstrom, 2007). During later language development (after 3;6 years), vocabulary and syntax appear to be less strongly related, and the development of these language domains becomes more autonomous (Bates & Goodman, 1997). It is important to note that children’s vocabulary development is not only critical for their grammatical development, but also for early literacy skills (Sénéchal, LeFevre, Smith-Chant, & Colton, 2001, Wagner, Muse & Tannenbaum, 2007). The importance of good vocabulary skills for a child’s further development thus seems evident, and difficulties in this development need to be mediated as early as possible.

*Language development in children with ID*

The pattern of language development for children with ID is less clear than it is for typically developing children. Most language domains develop in pace with the mental level of the children, and although delayed, it resembles the typical sequential language development at least to some extent (Kaiser et al., 2001; Rondal, 2001). However, the timing and outcomes of the language development of children with ID vary much more and are also characterized by more pervasive individual differences that often do not reflect the child’s mental age (e.g., major articulation, vocabulary, and/or syntax delays) (Kaiser et al., 2001).

Many children with ID also experience severe speech- and language disabilities as is often seen in children with autism, Down syndrome, Fragile X syndrome or Velo-Cardio-Facial syndrome (Landa, 2007; Rondal, 2001; Sphrintzen, 2000).

The individual differences in the language development of children with ID can be largely attributed to syndrome differences (Rondal, 2001). For example, children with Down syndrome show specific weaknesses in the areas of speech production, syntax, and the intelligibility of their speech (Roberts, Price, & Malkin, 2007). The difficulties of these children can partly be explained by poor phonological WM, which impairs their ability to detect and store phonetic patterns in an efficient manner (Hick, Botting, & Conti-Ramsden, 2005; Jarrold, Baddeley, & Phillips, 2002). On the contrary, children with Williams syndrome show specific strengths in vocabulary development, as these children can reach vocabulary levels far above their mental age (Mervis & Bertrand, 1997). Other children with ID have also been found to develop vocabulary skills that are higher than those of typically developing children with the same mental age. Often, these higher vocabulary levels can be explained by the higher chronological ages of the children with ID, which will have given them more life experiences, and these are highly correlated with vocabulary knowledge (Facon, Facon-Bollengier, & Grubar, 2002; Miolo, Chapman, & Sindberg, 2005). Although children with ID can acquire quite large vocabularies, they have more severe difficulties in developing syntax skills. In a study of Vicari, Caselli, and Tonucci (2000), an asynchrony between vocabulary and morphosyntactic abilities in children with Down syndrome was found. However, as in typical language development, vocabulary and syntax were still highly correlated for the children with Down syndrome, showing that, although quite disadvantaged, syntactic abilities were not dissociated of lexical abilities.

The varying language levels and atypical developmental trajectories in children with ID raise the question of what the influence of different levels of intelligence is on the language development of children. Not all studies have found developmental level to be predictive of later language skills (Calandrella & Wilcox, 2000; McCathren, Yoder, & Warren, 1999), while others did not include intelligence measures as predictors of language development. Furthermore, previous studies only included children from a specific subgroup (e.g., children with Down syndrome or autism), which gives limited information on the language development and the role of intelligence in all children with ID. Also, longitudinal studies of language development in young children with ID are scarce, especially those that include several aspects of language development (e.g., both vocabulary and syntax) and cognitive factors. This makes it difficult to form a comprehensive picture of the language development of children with ID and what role intelligence levels play within this language development.

## Role of the environment in language acquisition

*Home and school environment*

Children will develop their first language skills in interactions with people in their environment. Parents, caregivers, and siblings play an important role in the development of language and communication abilities of young children (Hart & Risley, 1995). Children with more advanced language abilities have parents who talk more, use richer and more diverse vocabularies, and produce longer and more complex sentences (Hart & Risley, 1995; Hoff, 2003; Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010). Individual differences in language abilities of children are associated with the socioeconomic status (SES) of the parents. It has been found that lower SES parents tend to talk less and to use less diverse speech (e.g., fewer word types and less diverse sentence types) than higher SES parents (Hoff, 2003). Situations in which parents and children engage in joint attention (e.g., storybook reading, play, and mealtime), with parents labeling objects in the direct environment have been found to be especially effective in stimulating early language development (Tomasello & Farrar, 1986).

In a similar vein, it has been found that the development of language and early literacy skills is especially fostered in a broader concept which is often referred to as the home literacy environments (HLE) in which children grow up (Sénéchal & LeFevre, 2002; Whitehurst & Lonigan, 1998). At home, children may have many literacy experiences; they play with books and writing materials, observe their parents' reading and writing and are being read to during storybook reading. The HLE is described as a construct that consists of several interrelated aspects, which all have a different influence on children's language and literacy development (Leseman & de Jong, 1998). For instance, storybook reading has been found to play an important role in supporting language and early literacy development within the home environment (Justice & Kaderavek, 2002). Especially the quality of storybook reading interactions and the amount of active participation of the child during these interactions are related to both receptive and expressive vocabulary development (Reese & Cox, 1999; Sénéchal, LeFevre, Hudson, & Lawson, 1996).

Besides the home environment, preschool may also play an important role in developing language and literacy skills. Within day-care and school facilities, children can have numerous communicative interactions with caregivers and peers, and these interactions have been found to be of major importance for their early language development (McCartney, 1984; NICHD Early Child Care Research Network, 2000). For example, quality of day-care centers, and especially the amount of verbal interactions between caregivers and children, positively affects children's language development, particularly their communicative competence (McCartney, 1984). Furthermore, caregiver and teacher expectations determine the manner in which they interact with children and the level and types of activities they will offer to the children (Peeters, Verhoeven, & De Moor, 2009; Stoep, Bakker, & Verhoeven, 2002).

*Communicative environments of children with ID*

For children with ID, it is of major importance that parents and teachers know how to best direct and accommodate their language and communication to their needs. That is, children with ID exhibit individual strengths and weaknesses, which require specific adaptations in their environment to stimulate their language development in an optimal way. When it comes to communication opportunities and learning new communication and language skills, children with ID depend on their communicative partners to a greater extent, as they often lack skills for effective early communication (e.g., joint attention skills) (Kaiser et al., 2001). By adjusting the communicative environment to the needs of the child and with appropriate support, children with ID can acquire high levels of communication and language skills (Kaiser et al., 2001).

While the communicative environments for children with ID should thus be more contingent and responsive to the child's lead, more often they are more directive and adult-guided than the communicative environments for typically developing children (Light, Collier, & Parnes, 1985a, 1985b; Mahoney & Wheeden, 1999). The parents of children with ID have been found to adapt their language and communication to the developmental level of the child, but this often results in less diverse and complex talk, which does not necessarily provide the most optimal environment to stimulate the child's communication and language development (Kaiser et al., 2001). Expanding children's utterances with more complex vocabulary, greater information, and/or more complete syntax in concrete and experiential settings optimizes the language learning and communicative competence of children to a greater extent (Kaiser, Hancock, & Hester, 1998; Romski, Sevcik, & Adamson, 1999). The HLE of children with ID has also been found to differ from the HLE of typically developing children (Weikle & Hadadian, 2004). They have fewer literacy materials present in their homes, are read to less frequently, and have less interactive and engaging storybook reading sessions as compared to their typically developing peers (Marvin, 1994; Trenholm & Mirenda, 2006).

In sum, the communicative environment of children with ID is not always the most stimulating for their language development. Therefore, varied and individualized adaptations of the communicative environments can be needed to support and stimulate the language development of children with ID. Previous research has shown early interventions to be effective in stimulating the language development of children with ID. For instance, Koegel, Camarata, Valdez-Menchaca, and Koegel (1998) taught question-asking strategies to children with autism in a clinical setting. This resulted in increased question-asking in different settings (e.g., the home) and in a growth in vocabulary learning. However, most interventions were designed to improve only a single aspect of children's language development, like speech intelligibility (Dodd, McCormack, & Woodyatt, 1994), grammatical development (Warren, Gazdag, Bambara, & Jones, 1994), or comprehension of linguistic concepts (Kim & Lombardino, 1991). Evidence-based interventions that target all domains of language, communication and literacy development, aiming at the children as well as their parents and caregivers, with clearly individualized intervention strategies, are scarce.

## The present study

### *Research questions and design*

The main aim of the present study was to shed further light on the language development of young children with ID by examining this development longitudinally. Previous research has shown children with ID to experience delays in language development (Kaiser et al., 2001; Rondal, 2001), however, questions remain about the way these children acquire language skills and what role different levels of intelligence and other cognitive factors play in this development. A second aim of the present study was to gain more knowledge about the environment in which children with ID acquire language. Although the importance of the communicative environment for a child's language development is acknowledged (Hart & Risley, 1995; Whitehurst & Lonigan, 1998), little is known about the home literacy environment of children with ID. Finally, evidence-based interventions in which the communicative environment of young children with ID is adjusted to be optimal for stimulating their language development are scarce. Therefore, the effectiveness of an immersive language intervention for preschool children is investigated as well.

To sum up, the following research questions are addressed in the present study:

1. What are the similarities and differences in language development between children with ID and typically developing children?
2. What are the differences in the home literacy environment of children with ID and typically developing children?
3. To what extent is an early language intervention effective in stimulating the language development of children with ID?

In the Netherlands, preschool children with ID attend day-care centers for children with disabilities from early on. They often attend these centers till the age of 5 years, after which they will enroll in either special education for children with learning disabilities, or special education for children with multiple disabilities. In the present study, children were located through the special day-care centers after which they were followed into their school environment. Inclusion criteria for the children were an intellectual disability (IQ between 50 and 75) as determined by a psychologist, within normal range hearing and vision levels, and Dutch as a first language. To reduce exclusion, children with additional impairments like autism or ADHD, were included in the study. However, at study entry most children did not have a specific diagnosis due to their young ages (4 years). A control group of same-aged children without disabilities was also followed. These children followed mainstream education, and did not show any developmental disabilities.

Furthermore, to study a newly developed early language intervention, a day-care centre for children with disabilities was asked to implement the intervention. Children could participate in the intervention if they fitted the inclusion criteria. These were an intellectual disability (nonverbal IQ below 75) as determined by a psychologist, severe speech- and language disabilities, chronological age at study entry between 2 and 6 years, a receptive language age of at least 1;6 years, active use of no more than 10 referential concepts (e.g., words, manual signs, graphic symbols), Dutch as a first language, and a cooperative home-environment. Children in the control group attended a day-care centre of the same organization at another location and were matched on age, gender, and etiology.

*Outline of the present thesis*

In Chapter 2 (*Language proficiency in children with intellectual disabilities: A neurocognitive perspective*) the language proficiency of children with ID is investigated in comparison with typically developing children with the same chronological age and the same mental age. Multivariate analyses of variance are performed to examine differences between the three groups. Furthermore, correlation and regression analyses are conducted to investigate which variables are good predictors of both vocabulary and syntax skills.

Chapter 3 (*How cognitive factors affect language development in children with intellectual disabilities*) examines the influence of the cognitive factors phonological working memory and nonverbal intelligence on the longitudinal development of vocabulary and syntax from age 4 to 5 in children with ID and their typically developing peers. By means of structural equation modeling (SEM) it is investigated what the respective roles are of phonological working memory and nonverbal intelligence for both groups of children separately. Attention will also be given to structural relationships between vocabulary and syntax over time.

In Chapter 4 (*Home literacy environment of preschool children with intellectual disabilities*) the home literacy environment (HLE) of children with ID is compared to those of typically developing children of the same chronological age and the same mental age. Several aspects of the home literacy environment (e.g., child's literacy interest, the child's activities during storybook reading, materials and parental activities for child's literacy development, parents' literacy materials and activities, and parents' expectations for their child's literacy development) of the children are examined through parent questionnaires. Factor analyses are performed to combine the individual items into different factors. To investigate differences between the HLE of children with ID and the two groups of typically developing children, multivariate analyses of variance are carried out. For the children with ID, it will be examined, by means of correlation analyses, to what extent relationships exist between the HLE and children's nonverbal intelligence, speech intelligibility, language and early literacy skills.

Chapter 5 (*Immersive communication intervention for speaking and non-speaking children with intellectual disabilities*) describes an early intervention designed to stimulate the language development, emergent literacy and communication skills of children with complex communication needs. The language development of individual children during the intervention in comparison to the development before the intervention, is studied by means of a proportional change index. Also, it will be examined to what extent differences in development during the intervention exist between speaking and non-speaking children.

Chapter 6 (*Early language intervention for children with intellectual disabilities: A neurocognitive perspective*) further examines the efficacy of the early language intervention described in Chapter 5. The effects of the intervention on the development of the children's nonverbal intelligence, receptive and productive language skills for the intervention group are compared to a control group. Long-term effects one year after completion of the intervention are also examined for the intervention children.

The final chapter of this thesis, Chapter 7, provides a general conclusion based on the preceding chapters. A discussion of the results as a whole will relate the findings to recent literature on language development in children with ID. Also, some limitations of the present study and directions for future research will be considered. The chapter ends with a number of implications for clinical practice that can be derived from the present findings.

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# Language Proficiency in Children with Intellectual Disabilities: A Neurocognitive Perspective*

*Chapter 2*

**Abstract**

In the present study the language proficiency of young children with intellectual disabilities (ID) was investigated in comparison with typically developing children with the same chronological age (CA) and the same mental age (MA). Recent neurocognitive studies revealed a tripartite structure of language processing (i.e., memory, unification, and control) and it was studied to what extent children with ID experience difficulties on these components. Results showed that in comparison to the MA group, children with ID showed specific impairments on the unification component and the control component, but not on the lexical memory component. Furthermore, the control component (i.e., phonological WM) was found to predict both the memory and unification component.

*This chapter is an adapted version of: Van der Schuit, M., Segers, E., Van Balkom, H., & Verhoeven, L. (resubmitted). Language performance of children with intellectual disabilities: The role of verbal short-term memory.

## Introduction

Many children with intellectual disabilities (ID) show difficulties in speech and language development (Kaiser, Hester, & McDuffie, 2001). While the language development of children with ID resembles the language development of typically developing children at least to some extent, the timing and outcomes vary much more and are also characterized by more pervasive individual differences that often do not reflect the child's mental age (Kaiser et al., 2001; Rondal, 2001). Children with ID have limitations in both lexical and syntactic development. In fact, they score lower than their typically developing peers on all cognitive and linguistic measurements (Kaiser et al., 2001). For example, children with Down syndrome show specific weaknesses in the areas of speech production, syntax, and the intelligibility of their speech (Roberts, Price, & Malkin, 2007). However, their performances on these skills are much lower than may be expected based on their intellectual functioning. Opposite results have also been found though; Facon, Facon-Bollengier, and Grubar (2002) found children with ID to have vocabulary levels above their mental age. The results of these studies are conflicting, and questions remain as to whether the language proficiency of children with ID resembles those of typically developing children with the same mental age and to whether they show specific strengths or weaknesses. To get a better understanding of the language proficiency of young children with ID, while taking into account their cognitive delay, we will make a comparison with a group of children with the same mental age (MA), as well as a group with the same chronological age (CA).

In studying this relation, we use a neurocognitive model for the processing and learning of language (Hagoort, 2005), which includes three essential components: a memory component which provides a basis for the storage and retrieval of lexical information (i.e., the mental lexicon); a unification component which is responsible for the merging and further syntactic processing of lexically retrieved information; and a control component which relates language to action. This MUC model (Memory, Unification, Control) can nicely be applied on neurolinguistic evidence from studies with persons who have complex communication needs (e.g., aphasia, intellectual disability) (cf. Van Balkom & Verhoeven, 2010). Behavioral research of the language development of typically developing children also shows this tripartite structure. The memory component develops slowly at first, but around the age of 18 months, when children have developed a productive vocabulary of 50 to 100 words, the growth of the mental lexicon accelerates rapidly in what is sometimes called a "vocabulary burst" (Fenson et al., 1994). Around the same time, children's first word combinations also appear, reflecting the first occurrence of the unification component. It can be assumed that a certain level of lexical development is needed in order to have syntactic development initiated. It has indeed been found that children need to actively use a minimum of 50 to 100 words before their syntactic development can begin, which is referred to as the "critical mass hypothesis" (Bates & Goodman, 1997; Marchman & Bates, 1994). This early syntactical knowledge of young children is thought to be organized around specific words, early gesture-word combinations and formulaic phrases or so-called templates from which they later abstract more general patterns to then be applied to new words and meanings (Akhtar, 1999; Lieven, Pine, & Baldwin, 1997; Tomasello, 2003).

The third component of the MUC model, the control component, is necessary for language learning. Language learning requires children to encode and extract patterns and regularities of the speech streams they hear. This learning happens mostly implicit and without conscious awareness, but does require a certain amount of cognitive control (Conway & Pisoni, 2008). For language learning, phonological working memory (WM) has been found to play an important role (Baddeley, 1986; Baddeley, Gathercole, & Papagno, 1998; Conway & Pisoni, 2008). Within this phonological WM, phonological information can be stored and rehearsed for a short period of time and it is thought to be important for long-term storage of information in the phonological memory (Baddeley, Papagno, & Vallar, 1988).

First of all, phonological WM is important for vocabulary learning. A strong association between phonological WM and vocabulary levels has indeed been found for typically developing children, also after controlling for general intelligence (for a review, see Baddeley et al., 1998). In a similar vein, Gathercole and Baddeley (1990) found that children who were better in non-word repetition learned new vocabulary at a faster rate than children with poor non-word repetition. Next to vocabulary learning, phonological WM has been found to be of importance for the acquisition of syntax (both receptive and productive). Children who have better phonological WM skills produce longer and grammatically more complex sentences (Adams & Gathercole, 1995). The comprehension of syntactically complex sentences (e.g., passive sentences) also leans on phonological WM, as these complex sentences require the child to keep longer sequences of auditory information in their WM. The phonological rehearsal of sequences of words in the WM helps children in learning phrases and most importantly to abstract syntactic patterns of these phrases (Ellis & Sinclair, 1996).

There have been several studies investigating WM in children with ID. It was shown that children with ID have difficulties with tasks involving phonological WM. Henry and Maclean (2002) found these children to score lower on working memory skills (phonological and visuo-spatial storage) than typically developing children with the same chronological age. In comparison to typically developing children with the same mental age, children with ID performed better on the visuo-spatial memory tasks, but worse on the word span task. This suggests that children with ID have specific weaknesses in phonological WM, and not in the visuo-spatial component of WM. Especially children with Down syndrome are found to be impaired in phonological WM (Baddeley & Jarrold, 2007; Lanfranchi, Jerman, & Vianello, 2009). This can explain the specific difficulties with speech production and syntactical skills of these children (Jarrold, Baddeley, & Phillips, 2002; Miolo, Chapman, & Sindberg, 2005). As in typically developing children, also for children with ID, there is a strong relationship between phonological WM and language skills. In a study of Jarrold, Baddeley, Hewes, Leeke, and Phillips (2004), children with ID of different ages and vocabulary levels were compared. It was found that phonological WM is causally related to the acquisition of vocabulary, with children who have difficulties in phonological WM taking a longer time to develop vocabulary.

What remains unclear, however, is whether children with ID show impairments on all three components of the MUC model, and to what extent performances on one component are predicted by performances on the other components. Studying relationships between language domains in young children with ID gives important insights that are useful for developing evidence-based, early language intervention programs for children with ID. In the present study, we tried to answer the above question by comparing the performances of children with ID on the three components of the MUC model with those of typically developing children with the same CA and children with the same MA. In this way, it could be studied what the influence of children's cognitive delay is on their language proficiency. Furthermore, for all three groups of children, it was studied to what extent relationships existed between the components of the MUC model and it was investigated which variables predicted abilities on the memory component (i.e., vocabulary) and the unification component (i.e., receptive and productive syntax). It was expected that vocabulary would largely be predicted by phonological WM skills (i.e., control component). Syntax was expected to be predicted by phonological WM skills and vocabulary. Both expectations were based on previous research in which the importance of the phonological WM for language learning was found (Baddeley et al., 1998) and on the 'critical mass' hypothesis in which a certain level of vocabulary is needed to develop grammar (Bates & Goodman, 1997; Marchman & Bates, 1994). To sum up, this study investigated the following research questions:

1. To what extent do children with ID show difficulties on the three components of the MUC model in comparison with typically developing children of the same chronological age and typically developing children of the same mental age?
2. To what extent does the control component of the MUC model explain variation on the memory component (i.e., vocabulary) of children with ID and typically developing children?
3. To what extent do the control component and the memory component of the MUC model explain variation on the unification component (i.e., receptive and productive syntax) of children with ID and typically developing children?

## Method

*Participants*

Participants in this study were 58 preschool and school children with ID, 42 typically developing children matched on CA, and 42 typically developing children matched on MA. All of the parents provided their informed consent for their child's participation in the study.

The children with ID attended special day-care centers and schools for children with ID in the Netherlands. This group consisted of 38 boys and 20 girls, with a mean chronological age of 5;6 years ($SD$ = 0.4, range 4;10 - 6;1 years). All children had an intellectual disability (nonverbal IQ: range 49-70, $M$ = 54.8, $SD$ = 7.0): 9 with Down or another syndrome, 14 with an accompanying disorder like autism or attention deficit hyperactivity disorder, 6 with brain damage or epilepsy, 3 with dyspraxia, 2 with a sensory impairment, 5 with psychomotor retardation and 19 with a yet unknown etiology of their ID. None of the children had severe hearing or vision loss and the primary language in the homes of all children was Dutch.

The typically developing children were recruited from regular day-care centers and schools in the Netherlands. The CA group consisted of 22 boys and 20 girls, with a mean chronological age of 5;2 years ($SD$ = 0.3, range 4;9 – 5;8 years). These children had no known impairments (nonverbal IQ range 90 – 137, $M$ = 114.2, $SD$ = 10.5) and the primary language at home was Dutch. The MA group consisted of 22 boys and 20 girls, with a mean chronological age of 3;1 years ($SD$ = 0.2, range 2;9 – 3;4 years). These children had no known impairments (nonverbal IQ range 76 – 138, $M$ = 109.8, $SD$ = 13.9) and the primary language at home was Dutch. The MA group and the children with ID did not differ on mental age ($t(98) = -.51$, $p = .613$, $d = 0.1$), but the typically developing children in the MA group had a significantly lower chronological age than the children with ID ($t(98) = 42.01$, $p < .001$, $d = 8.61$).

*Materials*

*Nonverbal intelligence.* Nonverbal intelligence was assessed using the Revised Snijders-Oomen Nonverbal Intelligence Test (SON-R 2 ½ - 7) (Tellegen, Winkel, Wijnberg-Williams, & Laros, 2005). This is a standardized test that does not use spoken or written language to measure nonverbal intelligence (Cronbach's alpha = .90). The test involves a reasoning scale (i.e., Situations, Categories, and Analogies) and a performance scale (i.e., Patterns, Mosaics, and Puzzles).

*Memory component.*

*Vocabulary.* In order to assess the child's vocabulary, a subtest of the the Schlichting Test for Language Production (Schlichting, Van Eldik, Lutje Spelberg, Van der Meulen, & Van der Meulen, 2003; Cronbach's alpha = .87) was administered. This subtest measures the productive vocabulary of a child by means of naming concrete objects and pictures.

*Unification component.*

*Receptive syntax.* In order to assess the child's receptive syntax the Dutch version of the Reynell Test for Language Comprehension (Van Eldik, Schlichting, Lutje Spelberg, Van der Meulen, & Van der Meulen, 2004) was administered. The Reynell measures both the passive vocabulary comprehension and comprehension of grammatical structures of children between 1;2 and 6;3 (Cronbach's alpha = .90).

*Productive syntax.* The child's productive syntax was assessed using a subtest of the Schlichting Test for Language Production (Schlichting et al., 2003; Cronbach's alpha = .85). This subtest measures the productive syntactic development of children by eliciting syntactic structures of different difficulty (e.g., one-, two- or three-word sentences) from the child through toys and pictures.

*Control component.*

*Word span.* Word span was assessed with the subtest 'auditory memory' of the Schlichting Test for Language Production (Schlichting et al., 2003; Cronbach's alpha = .85). The child had to repeat lists of words in the same order immediately after presentation. The task consists of 15 items in which the lists gradually increased from one to six words. A training item preceded the test items each time the list was increased with one word. The words are all nouns and per item words are from the same, partially the same or different semantic fields. Per item the words are also varied maximally on phonology and all words within a series start with different sounds. The task was terminated after the child had made three successive errors.

*Word repetition.* Word repetition was assessed with a subtest of the Dutch SLI Screening Test (Verhoeven, 2006; Cronbach's alpha = .94). In this task the child was instructed to repeat real words. Words were presented one at a time by a computer with recorded voice. The task consisted of 2 training and 40 test items of increasing difficulty, varying from one syllable up to five syllables. The task was terminated when the child had made five successive errors.

*Procedure*

The children were individually tested in a quiet room during their time at the day-care centre or school by a trained examiner. The test sessions lasted 30 to 45 minutes, depending upon the child's abilities and concentration. Up to four sessions were necessary for administration of the tests. For most of the children, the sessions were conducted on different days with no more than three weeks in between them.

The Reynell Test for Language Comprehension always preceded the Schlichting Test for Language Production. The instructions were provided verbally but supported with sign language when necessary for the particular child. Those children using Sign Supported Dutch (SSN) or sign language for production purposes were motivated to do so during their testing and all answers provided using manual signs were judged to be acceptable. For the Nonverbal Intelligence Test, instructions were also given through demonstration by the examiner. Moreover, after each item the child received feedback on his or her performance. If necessary, the examiner demonstrated the correct solution to the child.

Age equivalents that corresponded with the child's total scores on the tests for nonverbal intelligence, receptive language, and productive language were obtained by using the norms from the test manual. For word span and word repetition raw scores were used in the analyses, because no norms were available for these tests.

## Results

*Comparison with typically developing children*

In Table 1 the means and standard deviations of the assessed skills are shown for the children with ID, and the CA and MA groups of typically developing children. MANOVA results revealed significant differences between the three groups, Wilks' Lambda = .120, $F(12, 268) = 42.06$, $p < .001$, $\eta_p^2 = .653$.

Table 1. *Descriptive Statistics and MANOVA Results of the Variables (Age Equivalents in Months) for the Children with ID and the CA and MA group*

| | Variables | ID | | CA | | MA | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *M* | *SD* | *M* | *SD* | *M* | *SD* | *F* | $\eta_p^2$ | Post Hoc |
| | nonverbal intelligence | 39.7 | 7.59 | 70.3 | 7.90 | 40.4 | 5.62 | 265.01** | .792 | CA > MA = ID |
| Memory | vocabulary | 37.0 | 10.92 | 65.4 | 7.73 | 39.9 | 5.46 | 146.17** | .678 | CA > MA = ID |
| Unification | receptive syntax | 37.0 | 10.04 | 70.6 | 5.27 | 42.1 | 6.00 | 248.89** | .782 | CA > MA > ID |
| | productive syntax | 34.2 | 11.77 | 68.1 | 7.18 | 39.4 | 7.85 | 168.21** | .708 | CA > MA > ID |
| Control | word span | 4.2 | 2.67 | 9.6 | 1.55 | 5.3 | 2.67 | 64.79** | .482 | CA > MA = ID |
| | word repetition | 8.2 | 8.18 | 34.9 | 2.94 | 16.4 | 7.67 | 186.61** | .729 | CA > MA > ID |

** $p < .001$

Further Bonferroni post hoc group comparison tests revealed that the children in the CA group had significantly higher scores than the children in the MA group and the children with ID on all tasks (*p*s < .001). The children with ID scored significantly lower than the MA group on receptive syntax ($p < .01$), productive syntax ($p < .05$), and word repetition ($p < .001$), and marginally lower on word span ($p = .078$). For vocabulary and nonverbal intelligence no significant differences existed between the children with ID and the MA group.

*Correlations between variables*

Relationships between the components of the MUC model were first studied with Pearson correlations. Table 2 shows the correlations between the variables for the children with ID and for the CA and MA group. For the children with ID, the memory, unification and control components were all highly significantly correlated (*r*s > .54; *p*s < .01). For the CA and MA group comparable correlations existed, although for these groups there were fewer and less stronger relationships between the components.

Table 2. *Correlations between the Variables (Standard Scores) for the Children with ID and the CA and MA Group*

| | Variables | 1. | 2. | 3. | 4. | 5. | 6. |
|---|---|---|---|---|---|---|---|
| | | Children with ID (n = 58) | | | | | |
| | 1. nonverbal intelligence | - | | | | | |
| Memory | 2. vocabulary | .75** | - | | | | |
| Unification | 3. receptive syntax | .74** | .83** | - | | | |
| | 4. productive syntax | .54** | .78** | .70** | - | | |
| Control | 5. word span | .59** | .81** | .69** | .80** | - | |
| | 6. word repetition | .64** | .69** | .65** | .71** | .77* | - |
| | | MA group (n = 42) | | | | | |
| | 1. nonverbal intelligence | - | | | | | |
| Memory | 2. vocabulary | .37* | - | | | | |
| Unification | 3. receptive syntax | .40** | .65** | - | | | |
| | 4. productive syntax | .25 | .45** | .47** | - | | |
| Control | 5. word span | .04 | .24 | .31* | .46** | - | |
| | 6. word repetition | .10 | .35* | .09 | .30 | .39* | - |
| | | CA group (n = 42) | | | | | |
| | 1. nonverbal intelligence | - | | | | | |
| Memory | 2. vocabulary | .52** | - | | | | |
| Unification | 3. receptive syntax | .45** | .54** | - | | | |
| | 4. productive syntax | .27 | .36* | .33* | - | | |
| Control | 5. word span | .14 | .19 | .26 | .16 | - | |
| | 6. word repetition | .43** | . 34* | .28 | .25 | .39* | - |

* $p < .05$, ** $p < .01$

*Predictors of the memory component*

Hierarchical multiple regression analyses (enter method) were conducted for each group to investigate which variables are good predictors of the memory component (i.e., vocabulary). In Step 1 nonverbal intelligence was included as a predictor. In Step 2 the control component was included as a predictor by adding word span and word repetition (i.e., phonological WM skills) to the model.

For the children with ID Step 1 resulted in a significant model ($F(1, 56) = 73.06$, $p < .001$), with nonverbal intelligence explaining a significant proportion of variance in vocabulary skills ($R^2 = .57$, $p < .001$). After controlling for nonverbal intelligence, the phonological WM skills in Step 2 explained a significant proportion of unique variance in vocabulary skills ($\Delta R^2 = .20$, $p < .001$). Inspection of the standardized regression weights ($\beta$) revealed that this was due to word span. This final model resulted in a significant model ($F(3, 54) = 59.56$, $p < .001$), explaining 76.8 % of the variation in vocabulary skills. Table 3 shows the final results of the regression analysis.

Table 3. *Summary of Hierarchical Regression Analysis for Variables Predicting the Memory Component in Children with ID (n = 58), the CA Group (n = 42), and the MA Group (n = 42)*

| | ID | | MA | | CA | |
|---|---|---|---|---|---|---|
| Variable | $\Delta R^2$ | $\beta$ | $\Delta R^2$ | $\beta$ | $\Delta R^2$ | $\beta$ |
| Step 1 | .57*** | | .14* | | .27*** | |
| nonverbal intelligence | | .75*** | | .37* | | .52*** |
| Step 2 | .20*** | | .12† | | .02 | |
| word span | | .57*** | | .14 | | .08 |
| word repetition | | -.02 | | .27† | | .10 |
| Total $R^2$ | .77 | | .25 | | .29 | |
| Adjusted $R^2$ | .76 | | .20 | | .24 | |

* $p < .05$, ** $p < .01$, *** $p < .001$, † < .10

Table 3 also shows the results of the regression analysis for both groups of typically developing children. For the MA group Step 1 resulted in a significant model ($F(1, 40) = 6.43$, $p < .05$), with nonverbal intelligence explaining a significant proportion of variance in vocabulary skills ($R^2 = .14$, $p < .05$). After controlling for nonverbal intelligence, the phonological WM skills in Step 2 explained a marginally significant proportion of unique variance in vocabulary skills ($\Delta R^2 = .12$, $p = .064$). Inspection of the standardized regression weights ($\beta$) revealed that this was due to word repetition ($p = .072$). This final model resulted in a significant model ($F(3, 38) = 4.32$, $p < .05$), explaining 25.4 % of the variation in vocabulary skills.

For the CA group Step 1 resulted in a significant model ($F(1, 40) = 14.98$, $p < .01$), with nonverbal intelligence explaining a significant proportion of variance in vocabulary skills ($R^2 = .27$, $p < .001$). After controlling for nonverbal intelligence, the phonological WM skills in Step 2 did not produce a significant increment of the variance explained ($\Delta R^2 = .02$, $p = .566$). For the CA group nonverbal intelligence was the only significant predictor of vocabulary skills.

*Predictors of the unification component*

In a similar vein hierarchical multiple regression analyses (enter method) were conducted for each group to investigate which variables are good predictors of the unification component. Receptive and productive syntax were taken together as one variable representing unification skills and this was used as the dependent variable. In Step 1 nonverbal intelligence was included as a predictor. In Step 2 word span and word repetition (i.e., phonological WM skills) representing the control component were added to the model and in Step 3 the memory component (i.e., vocabulary) was included.

For the children with ID Step 1 resulted in a significant model ($F(1, 56) = 49.01$, $p < .001$), with nonverbal intelligence explaining a significant proportion of variance in syntax skills ($R^2 = .47$, $p < .001$). After controlling for nonverbal intelligence, the phonological WM skills in Step 2 explained a significant proportion of unique variance in syntax skills ($\Delta R^2 = .27$, $p < .001$). Inspection of the standardized regression weights ($\beta$) revealed that this was due to word span. Vocabulary in Step 3 explained a significant proportion of variance in syntax skills ($\Delta R^2 = .08$, $p < .001$). This final model was also significant ($F(4, 53) = 55.09$, $p < .001$), explaining 80.6 % of the variation in syntax skills. Table 4 shows the final results of the regression analysis.

Table 4. *Summary of Hierarchical Regression Analysis for Variables Predicting the Unification Component in Children with ID (n = 58), the CA Group (n = 42), and the MA Group (n = 42)*

| | ID | | MA | | CA | |
|---|---|---|---|---|---|---|
| Variable | $\Delta R^2$ | $\beta$ | $\Delta R^2$ | $\beta$ | $\Delta R^2$ | $\beta$ |
| Step 1 | .47*** | | .13* | | .18** | |
| nonverbal intelligence | | .68*** | | .37* | | .42** |
| Step 2 | .27*** | | .20** | | .04 | |
| word span | | .52*** | | .31** | | .15 |
| word repetition | | .17 | | .11 | | .11 |
| Step 3 | .08*** | | .19** | | .11* | |
| vocabulary | | .57*** | | .50** | | .40* |
| Total $R^2$ | .81 | | .52 | | .33 | |
| Adjusted $R^2$ | .79 | | .47 | | .26 | |

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 4 also shows the results of the regression analysis for both groups of typically developing children. For the MA group Step 1 resulted in a significant model ($F(1, 40) = 6.14$, $p < .05$), with nonverbal intelligence explaining a significant proportion of variance in syntax skills ($R^2 = .13$, $p < .05$). After controlling for nonverbal intelligence, the phonological WM skills in Step 2 explained a significant proportion of unique variance in syntax skills ($\Delta R^2 = .20$, $p < .01$). Inspection of the standardized regression weights ($\beta$) revealed that this was due to word span. Vocabulary in Step 3 explained a significant proportion of variance in syntax skills ($\Delta R^2 = .19$, $p < .01$). This final model was also significant ($F(4, 37) = 10.11$, $p < .001$), explaining 47.1 % of the variation in syntax skills.

For the CA group Step 1 resulted in a significant model ($F(1, 40) = 8.54$, $p < .01$), with nonverbal intelligence explaining a significant proportion of variance in syntax skills ($R^2 = .18$, $p < .01$). After controlling for nonverbal intelligence, including phonological WM skills in the model in Step 2 did not result in a significant increment of the variance explained ($\Delta R^2 = .04$, $p = .370$). Vocabulary in Step 3 explained a significant proportion of variance in syntax skills ($\Delta R^2 = .11$, $p < .05$). This final model was also significant ($F(4, 37) = 4.58$, $p < .01$), explaining 33.1% of the variation in syntax skills.

## Conclusions and discussion

In the present study, it was investigated what the influence of children's cognitive delay is on their language proficiency. It was studied to what extent children with ID show delays on the primary neurocognitive components of lexical memory, unification and control. It was found that children with ID lag behind typically developing children of the same CA, which is in line with previous research (e.g., Kaiser et al., 2001). However, also in comparison to a MA matched group, children with ID showed impairments on the unification component (both syntax comprehension and production), and the control component (i.e., phonological WM skills), but not on the lexical memory component (i.e., vocabulary).

Further analyses trying to explain variation in this lexical memory component showed that for children with ID and the MA group, vocabulary level is predicted by both nonverbal intelligence and phonological WM skills whereas for the CA group the level of nonverbal intelligence mostly predicts vocabulary level. This indicates that children with lower vocabulary levels may still use a different strategy in vocabulary learning, in which they rely more heavily on phonological WM than children who have already acquired a larger vocabulary. This is in line with the suggestion of Gathercole, Willis, Emslie, and Baddeley (1992) that there is a developmental shift in the relationship between WM skills and vocabulary around 5 years. They found that at earlier ages phonological WM performances predicted vocabulary, but that this changed with vocabulary being a stronger predictor of phonological WM performances at ages above 5 years. Furthermore, in a study of Cheung (1996) it was also found that nonword repetition predicted novel word learning for children with a vocabulary below the median level of the group, but not for children with a higher level of vocabulary.

Phonological WM was found to be an important predictor of vocabulary level for both the children with ID and the MA group. MANOVA results revealed that the children with ID score significantly lower on word repetition and marginally significantly lower on word span than the MA group. This means that the children with ID have lower phonological WM skills than could be expected, based on their mental age. As a result of these lower phonological WM skills, they show significant delays in vocabulary learning. This is consistent with a study of Jarrold et al. (2004) in which they found that children who have difficulties in phonological WM need more time to develop vocabulary. The fact that, despite their lower phonological WM skills, the children with ID showed comparable vocabulary levels as the MA group, can be explained by the higher chronological ages of the children with ID. With their chronologically older age also come more life experiences and these are highly correlated with vocabulary knowledge (Facon et al., 2002; Miolo et al., 2005). In comparison with the CA group, who will have had the same amount of experiences, children with ID showed lower vocabulary levels.

The deficiencies in phonological WM of the children with ID may not only lead to a smaller vocabulary size, but may also lead to less adequate (phonological) storage of vocabulary and as a result to less elaborate mental lexicons. As children acquire words and greater experiential knowledge of the world, they typically form networks of concepts and interconnected meaning associations with various semantic, syntactic, and phonological relationships or what is often referred to as a "mental lexicon" (Aitchison, 1994). Children with ID can be assumed to have less elaborate and more superficially organized mental lexicons than children with normal intellectual abilities (Leonard & Deevy, 2004). Less elaborate and more superficially organized mental lexicons are based on weak links between the various components. This will not only hinder children's further vocabulary development but also their phonological and grammatical development.

Furthermore, to answer the third research question what variables could explain variation in abilities on the unification component (i.e., syntax) of children with ID and typically developing children, more regression analyses were done. For both the children with ID and the MA group, it was found that, next to nonverbal intelligence, vocabulary and word span are the most important predictors of syntax level. For the CA group, syntax level was only predicted by vocabulary and nonverbal intelligence. Vocabulary thus was a strong predictor of syntax level for all children, and this is consistent with previous research showing a strong relationship between vocabulary and syntax development (Bates & Goodman, 1997; Marchman & Bates, 1994).

For the MA group and the children with ID, syntax skills were also predicted by phonological WM skills (i.e., word span). This is in line with previous research which found that phonological WM is important for the development of syntax comprehension and production (Adams & Gathercole, 1995; Ellis & Sinclair, 1996) in the early stages of language learning. This also explains why in the CA group phonological WM no longer was a significant predictor of syntax level. The importance of phonological WM for syntax level also indicates that the found deficiencies of children with ID on phonological WM may result in difficulties in syntax learning. The children with ID indeed showed specific difficulties with syntactic skills in comparison with the MA group. These deficiencies in phonological WM seem to affect syntactic comprehension (e.g., receptive language) as was also found in a study of Miolo et al. (2005). They found strong relationships between phonological WM and sentence comprehension for individuals with Down syndrome. Limitations in phonological WM may result in difficulties with implicit learning of grammatical rules, because it becomes harder to infer and abstract structured patterns from the verbal sequences heard (Conway & Pisoni, 2008) when adequate temporal storage in working memory hampers. The development of syntax may be further hindered by difficulties in phonological WM as the production of a multi-word utterance requires the WM to maintain a certain amount of lexical items active while unification operations are done (Hagoort, 2005). This may explain why children who have better phonological WM skills produce longer and grammatically more complex sentences (Adams & Gathercole, 1995).

There are some limitations on the present study worth mentioning. First of all, no assessments of attention were done. As the control component of language learning not only consists of phonological WM, but also includes a central executive as an attentional controller, this should also be investigated for children with ID. Furthermore, many children with ID had articulation difficulties, which may have influenced their ability to articulate words or repeat lists of words. However, their articulatory difficulties can also be a result of deficiencies in phonological WM. Further research to investigate the relationships between phonological WM and articulation skills in children with ID is therefore necessary. Future research should not only make use of behavioral tasks to study language proficiency in children with ID. The use of neuroimaging studies could shed further light on the question whether brain structures that are thought to be important for typical language development (e.g., the left inferior frontal cortex being specialized in unification operations), show the same activity in persons with ID (Hagoort, 2005).

Some important clinical implications can be derived from this study. First of all, the results imply that early attention should be given to phonological WM in children with ID. As children with ID seem to have difficulties with phonological WM and therefore with the processing of speech, it is important that their communication partners slow their rates of speech in order to give these children more time to process, encode, store and retrieve the phonological information (Ellis Weismer, 1996). Furthermore, children with ID may need more extensive and explicit practice to develop grammatical rules, because their limitations in phonological WM make it harder to abstract structured patterns of the verbal sequences heard (Conway & Pisoni, 2008). They need more models, as they find it more difficult to abstract universal patterns from the receptively heard language sequences. On the other hand, visuo-spatial memory seems to be less impaired in children with ID, therefore, the transient auditory information (e.g., speech) could be supported with more stable, visual-graphic information (e.g., pictograms, drawings) and objects as tangible symbols. Introducing forms of Augmentative and Alternative Communication (AAC) can be an effective way to stimulate receptive language understanding (e.g., vocabulary) and it does not impede verbal speech development (Light, 1997; Millar, Light, & Schlosser, 2006).

In early interventions, attention should be given to all three components of language learning, as the development of lexical memory, unification, and control is often interdependent (Baddeley et al., 1998; Bates & Goodman, 1997; Marchman & Bates, 1994). An immersive intervention that takes the large individual differences between children with ID into account and stimulates the children's language via the development of their vocabularies and the use of AAC can result in significant learning gains in both cognitive and language skills among children with ID. Stimulating vocabulary growth via the provision of experiential and multimodal language learning indeed resulted in the building of more extensive mental lexicons, which resulted in an acceleration of vocabulary and grammatical development during the intervention period (Van der Schuit, Segers, Van Balkom, Stoep, & Verhoeven, 2010).

To conclude, this study showed that children with ID have specific impairments on phonological WM skills and syntactic comprehension and production in comparison with typically developing children of the same mental age. Phonological WM was found to predict both vocabulary and syntax skills. Although vocabulary levels of the children with ID seemed comparable to those of the MA group, the deficiencies in the area of phonological WM may still have resulted in less adequate storage of vocabulary and therefore in a less elaborate mental lexicon. In this way, the problems with phonological WM will also lead to difficulties in the acquisition of syntax, as this is highly dependent on vocabulary learning. Early attention should therefore be given to phonological WM skills of children with ID, as difficulties in this control component can lead to both difficulties in the memory and the unification component of language processing.

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# How Cognitive Factors affect Language Development in Children with Intellectual Disabilities[*]

*Chapter 3*

**Abstract**

The present study investigated the language development of 50 children with intellectual disabilities (ID) and 42 typically developing children from age 4 to 5 years, and was designed to shed more light on the respective roles of phonological working memory (WM) and nonverbal intelligence in vocabulary and syntax development. Results showed that nonverbal intelligence predicted phonological WM, vocabulary and syntax of children with ID at age 4 and 5, and that it only predicted these skills at age 4 in typically developing children. Furthermore, syntax at age 5 was predicted by vocabulary at age 4 in children with ID, which points to children with ID requiring a larger critical mass of vocabulary for syntactic development to be initiated.

[*]This chapter was published as: Van der Schuit, M., Segers, E., Van Balkom, H., & Verhoeven, L. (2011). How cognitive factors affect language development in children with intellectual disabilities. *Research in Developmental Disabilities, 32*, 1884-1894.

## Introduction

The language development of children with intellectual disabilities (ID) often shows delays, and the cognitive disabilities of these children are thought to be the main cause of these delays (e.g., cognition hypothesis (Cromer, 1991). This view, however, seems to be too limited (Rondal, 2001). Although in many studies the language level has been found to be in pace with the mental age of the children with ID (Rondal, 2001), other studies found great variation in linguistic areas that develop faster or slower than could be expected based on the mental level of the children. For example, children with Down syndrome show specific weaknesses in the areas of speech production, syntax, and the intelligibility of their speech (Roberts, Price, & Malkin, 2007). On the other hand, some children with ID have vocabulary levels far above their mental age (Facon, Facon-Bollengier, & Grubar, 2002), and with appropriate support, children with ID can acquire high levels of communication and literacy skills (Kaiser, Hester, & McDuffie, 2001; Koppenhaver & Erickson, 2003; Van der Schuit, Segers, Van Balkom, Stoep, & Verhoeven, 2010).

These varying language levels of children with ID raise the question of what the influence of different levels of intelligence is on the language development of children. Not all studies have found developmental level to be predictive of later language skills (Calandrella & Wilcox, 2000; McCathren, Yoder, & Warren, 1999), while others did not include intelligence measures as predictors of language development. Often, studies only included children with the same etiology (e.g., Down syndrome), which gives valuable information about strengths and weaknesses of the specific syndrome, but does not shed further light on the influence of intelligence on language development of all children with low intelligence. The present study, therefore, included children with a range of etiology to shed more light on the influence of intelligence levels on the language development of children with ID and their typically developing peers.

Children need several cognitive functions through which they acquire the language aspects that enable them to become competent language users. First, children need to learn how to segment the stream of speech sounds they hear into meaningful language units (e.g., words). This phonological development requires a certain amount of cognitive control from children, although it happens mostly implicit and without conscious awareness (Conway & Pisoni, 2008). Especially working memory (WM) plays a major role in language acquisition, as it allows for short-term storage or rehearsal of information, which is known to support long-term storage (Baddeley, 1986; Ellis & Sinclair, 1996). WM consists of three systems, namely the central executive, which serves as an attentional controller, and two separate systems for short-term storage of visuospatial and phonological information (i.e., the visuospatial sketchpad and the phonological loop). The phonological loop, in which phonological information can be stored and rehearsed for a short period of time, has been found to be the most important system of WM for language learning (Baddeley, 1986; Baddeley, Gathercole, & Papagno, 1998; Conway & Pisoni, 2008). Strong correlations exist between phonological WM and vocabulary and syntax skills of typically developing children (Baddeley et al., 1998). Children who are better in non-word repetition learn new vocabulary at a faster rate (Gathercole & Baddeley, 1990), and children with better phonological WM skills also show better syntax skills (e.g., longer and more complex sentences) (Adams & Gathercole, 1995).

Secondly, children need to learn that language sounds represent certain objects or actions. Around the age of 18 months, children start to sort objects into categories (Gopnik & Meltzoff, 1987, 1992). The ability to categorize objects marks an important shift in children's cognitive development, and it is thought to be the moment that children start to realize that each object belongs to a category. This new realization is also associated with an increase in the rate with which new words are learned (Gopnik & Meltzoff, 1987, 1992; Mandler, 2004). Children's first words are learned in a more associationist mode, with children linking the sound patterns they hear to specific objects or actions after repeatedly being presented together (Nazzi & Bertoncini, 2003). This is a time-consuming process, with a slow learning rate, and children may use words only in specific situations or for specific objects. The moment (around 18 months) children learn that objects can be categorized and that different objects and events each have their own *label*, is typically seen when children have around 50-100 productive words. At the same moment, there is a 'vocabulary burst', with children adding up to seven new words per day to their vocabularies (Fenson et al., 1994).

This 'vocabulary burst' is typically accompanied by the onset of syntactic development, as at this point the first word combinations also appear. A certain level of lexical development is thus needed in order to have syntactic development initiated; this is referred to as the 'critical mass hypothesis' (Bates & Goodman, 1997; Marchman & Bates, 1994). The development of syntax has indeed been found to begin at the time children actively use a minimum of 50 to 100 words. At first, children's syntactical knowledge is organized around specific words, early gesture-word combinations, and formulaic phrases or so-called templates, from which they later abstract more general patterns to then be applied to new words and meanings (Akhtar, 1999; Lieven, Pine, & Baldwin, 1997; Tomasello, 2003).

In typical language development, the early development of vocabulary and syntax are thus highly interdependent (Dionne, Dale, Boivin, & Plomin, 2003). This process, in which abilities on one language skill predict the development of other language skills, is called bootstrapping (Gleitman, 1990). First, until 2;6 years of age, lexical bootstrapping is mostly observed, with lexical development predicting grammatical development (Bates & Goodman, 1997; Marchman & Bates, 1994). Then syntactic bootstrapping becomes dominant, with syntactic knowledge facilitating later lexical development (Jones Moyle, Ellis Weismer, Evans, & Lindstrom, 2007). During later language development (after 3;6 years) these two components appear to be less strongly related, and the development of these components becomes more autonomous (Bates & Goodman, 1997).

It remains unclear, however, whether such bootstrapping mechanisms can also be observed in children with ID. For children with ID, lower general levels of intelligence can interfere with the ability to categorize objects and as a result hinder further lexical development. While vocabulary development often keeps up with mental age, it can be suggested that, although delayed, most children with ID seem to follow the same developmental pathways as typically developing children. It has indeed been found that, at least in children with Down syndrome, the vocabulary spurt and the ability to categorize objects occur at the same time (Mervis & Bertrand, 1995). However, for children with Williams syndrome, atypical developmental trajectories have been observed. For these children, the vocabulary spurt often precedes the ability to categorize objects (Mervis & Bertrand, 1997), and sometimes, in spite of large vocabularies, the categorizing abilities seen in typically developing infants are still not observed in children with Williams syndrome in adulthood (Stevens & Karmiloff-Smith, 1997). It is suggested that children with Williams syndrome continue to acquire their lexicon through an associationist mode, in which they link the sound patterns they hear to specific objects or actions after repeatedly being presented together (Nazzi & Bertoncini, 2003). This highlights the importance of the other cognitive factor, phonological WM, for language development.

Similar to typically developing children, there is a strong relationship between phonological WM and vocabulary in children with ID (Jarrold, Baddeley, Hewes, Leeke, & Phillips, 2004). However, children with ID have difficulties with tasks involving phonological WM (Jarrold & Baddeley, 1997; Van der Molen, Van Luit, Jongmans, & Van der Molen, 2007). They have lower WM skills, both in phonological and visuospatial storage, than same-aged typically developing children. The phonological WM of children with ID seems to be more affected than visuospatial memory, because when compared to younger typically developing children with the same mental age, children with ID performed better on the visuospatial memory tasks, but worse on the word span task (Henry & Maclean, 2002). Within the group of children with ID, especially children with Down syndrome are found to be impaired in phonological WM (Baddeley & Jarrold, 2007; Lanfranchi, Jerman, & Vianello, 2009; Miolo, Chapman, & Sindberg, 2005). This may explain why these children fail to develop good vocabularies, in spite of showing exhaustive categorization abilities.

Research has thus shown that children with ID experience delays in vocabulary acquisition, with their vocabulary level keeping up with mental age (Roberts et al., 2007; Vicari, Caselli, & Tonucci, 2000). But some studies have found children with ID to have vocabulary levels above their mental age (Facon et al., 2002; Miolo et al., 2005). This finding can be explained by the higher chronological ages of the children with ID, giving them more life experiences, which are highly correlated with vocabulary knowledge (Facon et al., 2002; Miolo et al., 2005). Although children with ID can acquire quite large vocabularies, specific difficulties are apparent for syntactic development. Vicari et al. (2000) found an asynchrony between vocabulary and morphosyntactic abilities in children with Down syndrome. However, the two components still were highly correlated, showing that, although quite disadvantaged, syntactic abilities were not dissociated of lexical abilities.

As mentioned above, both language skills and cognitive factors have been studied in isolation in children with ID, however, they have not been integrated into one longitudinal design in young children with ID. Therefore, the question remains what the respective roles are of phonological WM and nonverbal intelligence in vocabulary and syntax development of young children with ID, and whether comparable relationships are found in typically developing children. In the present study, the development of phonological WM, vocabulary and syntax skills was followed from age 4 to 5 in children with ID and their typically developing peers. We examined what relationships exist between vocabulary and syntax skills, and in what way phonological WM affects the development of vocabulary and syntax in children with ID and typically developing children from age 4 to 5. Phonological WM was included in the analyses at the same level as vocabulary and syntax, as it taps into both cognitive and linguistic domains (Christophe, Guasti, Nespor, Dupoux, & Van Ooyen, 1997; Hagoort, 2005). Finally, to investigate the role of nonverbal capacity on the development of vocabulary and syntax and its relationship with phonological WM for children with ID and typically developing children, nonverbal intelligence was included in the analyses as an independent variable.

## Method

*Participants*

Participants were 50 children with ID and 42 children without disabilities. Children were recruited through the day care centers or schools they attended. All parents provided their informed consent prior to participation.

The children with ID were 4;4 years;months (range 3;9 – 4;11: *SD* = 0.4) at the start of the study. The group consisted of 34 boys and 16 girls (nonverbal IQ: range 49-88, *M* = 58.2, *SD* = 11.4): 8 with Down or another syndrome, 10 with an accompanying disorder like autism or attention deficit hyperactivity disorder, 3 with brain damage or epilepsy, 2 with dyspraxia, 1 with a sensory impairment, 5 with psychomotor retardation and 21 with a yet unknown etiology. None of the children had severe hearing or vision loss and the children's primary language was Dutch.

The comparison group of typically developing children had a chronological age of 4;2 years;months (range 3;9 – 4;9: *SD* = 0.3) at the start of the study. The comparison group consisted of 22 boys and 20 girls. These children had no known impairments (nonverbal IQ: range 92-134, *M* = 115.6, *SD* = 10.2) and the children's primary language was Dutch.

*Materials*

*Nonverbal intelligence.*

Nonverbal intelligence was assessed using the Revised Snijders-Oomen Nonverbal Intelligence Test (SON-R 2 ½ - 7) (Tellegen, Winkel, Wijnberg-Williams, & Laros, 2005), which does not use spoken or written language (Cronbach's alpha = .90). The test involves a reasoning scale (i.e., Situations, Categories, and Analogies) and a performance scale (i.e., Patterns, Mosaics, and Puzzles).

*Phonological working memory.*

*Word span.* Word span was assessed with the subtest 'auditory memory' of the Schlichting Test for Language Production (Schlichting, Van Eldik, Lutje Spelberg, Van der Meulen, & Van der Meulen, 2003; Cronbach's alpha = .85). The child had to repeat lists of words in the same order immediately after presentation. The task consists of 15 items in which lists gradually increase from one to six words. A training item precedes the items each time the list increases with one word. The words are all nouns and per item words are from the same, partially the same or different semantic fields. Per item the words are also varied maximally on phonology and all words within a series start with different sounds. The task was terminated after the child made three successive errors.

*Word repetition.* Word repetition was assessed with a subtest of the Dutch SLI Screening Test (Verhoeven, 2006; Cronbach's alpha = .94), in which children need to repeat real words. Words are presented one at a time by a computer with recorded voice. The task consists of 2 training and 40 test items of increasing difficulty, varying from one syllable up to five syllables. The task was terminated when the child made five successive errors.

*Vocabulary.*

In order to assess the child's vocabulary, a subtest of the the Schlichting Test for Language Production (Schlichting et al., 2003; Cronbach's alpha = .87) was administered. This subtest measures the productive vocabulary of a child by means of naming concrete objects and pictures.

*Syntax.*

*Receptive syntax.* Receptive syntax was assessed using the Dutch version of the Reynell Test for Language Comprehension (Van Eldik, Schlichting, Lutje Spelberg, Van der Meulen, & Van der Meulen, 2004), which is designed to measure comprehension of grammatical structures of children between 1;2 and 6;3 (Cronbach's alpha = .90).

*Productive syntax.* Productive syntax was assessed using a subtest of the Schlichting Test for Language Production (Schlichting et al., 2003; Cronbach's alpha = .85), which measures the productive syntactic development of children by eliciting syntactic structures of different difficulty (e.g., one-, two- or three-word sentences) from the child by using toys and pictures.

*Procedure*

The children were tested during their time at day care centre or school. Each child was assessed individually in a quiet room by a trained examiner. Test sessions lasted 30-45 minutes, depending upon the child's concentration and abilities. About four sessions per child were necessary for administration of the tests. For most children, sessions were conducted on different days within a period of no more than three weeks. Similar procedures were adopted at both Time points (i.e., at ages 4 and 5 years).

The Reynell Test for Language Comprehension was always administered prior to the Schlichting Test for Language Production. Instructions were provided verbally, but supported with sign language as necessary for a particular child. Those children using Sign Supported Dutch or sign language for production were encouraged to do so during their testing and all answers provided using manual signs were judged to be acceptable. For the Nonverbal Intelligence Test, instructions were also given through demonstration by the examiner. Moreover, the child received feedback after each item, and, if necessary, the examiner demonstrated the correct solution.

Age equivalents and standard scores that corresponded with the child's total scores on the tests for nonverbal intelligence, receptive language, and productive language were obtained using the norms from the relevant test manuals. For word span and word repetition raw scores were used in the analyses, because no norms are available for these tests.

*Statistical Analyses*

Data were analysed in several steps. First, means and standard deviations were obtained for all measurements at ages 4 and 5. To compare the development of the two groups, Multivariate Analyses of Variance (MANOVA's) were performed with group as a between-subjects variable and time as a within-subject variable. Furthermore, to investigate whether differences between groups could be explained by nonverbal intelligence, MANOVA's were rerun with nonverbal intelligence included as a covariate. Finally, Structural Equation Modeling (SEM) was used to investigate the longitudinal development of the language skills and the influence of phonological WM and nonverbal intelligence.

## Results

*Descriptive statistics*

Table 1 shows the means and standard deviations of the assessed variables for the two groups. MANOVA results revealed significant differences between the two groups on all variables at age 4 (Wilks' Lambda = .142, $F(6, 85) = 85.55$, $p < .001$, $\eta_p^2 = .86$) and at age 5 (Wilks' Lambda = .138, $F(6, 85) = 88.79$, $p < .001$, $\eta_p^2 = .862$). The children with ID scored below the typically developing children on all tasks.

Because the children with ID scored lower on nonverbal intelligence than the typically developing children, the above analyses were repeated using nonverbal intelligence as a covariate. Differences between the groups remained, except for vocabulary at age 4 ($F(1, 89) = .52$, $p = .473$, $\eta_p^2 = .01$), vocabulary at age 5 ($F(1, 89) = .02$, $p = .893$, $\eta_p^2 \leq .01$), and word span at age 5 ($F(1, 89) = 2.02$, $p = .159$, $\eta_p^2 = .02$).

Table 1. *Descriptive Statistics and MANOVA Results of the Variables (Age Equivalents in Months) for the Children with ID (n=50) and the Typically Developing Children (n=42)*

| | Variables | ID | | Comparison | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *M* | *SD* | *M* | *SD* | *F* | $\eta_p^2$ | *p* |
| Time 1 | | | | | | | | |
| | nonverbal intelligence | 32.7 | 7.00 | 58.4 | 7.69 | 280.92 | .757 | <.001 |
| | vocabulary | 31.1 | 10.49 | 54.2 | 6.89 | 149.27 | .624 | <.001 |
| | receptive syntax | 30.8 | 9.11 | 61.6 | 10.24 | 232.14 | .721 | <.001 |
| | productive syntax | 28.7 | 8.47 | 60.8 | 10.55 | 261.58 | .744 | <.001 |
| | word span | 2.8 | 2.52 | 8.0 | 1.73 | 129.48 | .590 | <.001 |
| | word repetition | 5.6 | 5.75 | 28.4 | 5.48 | 375.37 | .807 | <.001 |
| Time 2 | | | | | | | | |
| | nonverbal intelligence | 40.3 | 9.04 | 70.3 | 7.90 | 281.75 | .758 | <.001 |
| | vocabulary | 38.0 | 12.78 | 65.4 | 7.73 | 147.65 | .621 | <.001 |
| | receptive syntax | 37.1 | 11.48 | 70.6 | 5.27 | 302.62 | .771 | <.001 |
| | productive syntax | 34.1 | 10.35 | 68.1 | 7.18 | 321.48 | .781 | <.001 |
| | word span | 4.3 | 2.66 | 9.6 | 1.55 | 127.15 | .586 | <.001 |
| | word repetition | 9.9 | 8.25 | 34.9 | 2.94 | 348.02 | .795 | <.001 |

*The role of phonological WM*

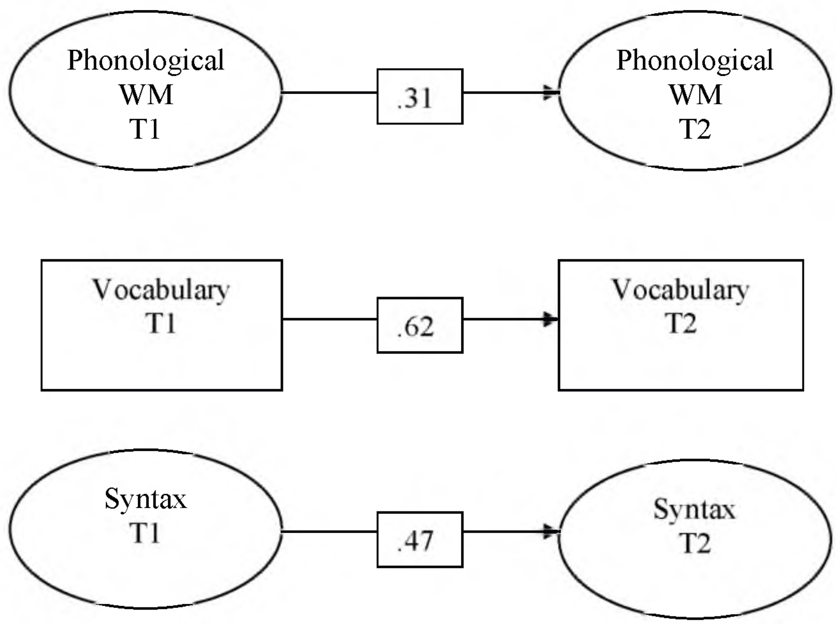
To answer the first research question, how phonological WM affects the language development of children with ID and typically developing children from age 4 to 5, two series of SEM analyses were done for the children with ID and the typically developing children separately, using Lisrel (Jöreskog & Sörbom, 2006). The error terms of the tasks measured at the same age were allowed to correlate. The corresponding correlation matrices can be found in Appendices A and B. Goodness of fit of the models was assessed by several fit indices: the standard $\chi^2$ test with degrees of freedom and *p*-value, the Goodness of Fit Index (GFI), the Adjusted Goodness of Fit Index (AGFI), the Comparative Fit Index (CFI), the Normed Fit Index (NFI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR). The fit of a model is judged as acceptable if the ratio of the chi-square to the degrees of freedom is smaller than 2:1. The GFI, NFI, and CFI should ideally be between .90 and 1.00 (Hu & Bentler, 1999), and AGFI should be above .85 (Kline, 1998). Furthermore, to reflect a good fit RMSEA should be below .06. Finally, SRMR should be below .08, although values below .10 are considered acceptable (Hu & Bentler, 1999).

Figure 1 shows the final SEM model for the typically developing children (1a) and the children with ID (1b). The goodness-of-fit indices of both models are presented in Table 2. The different indices suggested that the models were acceptable for both groups. All relationships presented in Figure 1 were significant with $p < .05$. For the typically developing children, phonological WM was not found to affect any of the language skills from age 4 to 5. Also, no structural relationships were found between vocabulary and syntax from age 4 to 5. This means that each variable (e.g., phonological WM, vocabulary, and syntax) at age 4 only predicted the same variable at age 5. For the children with ID, however, it was observed that vocabulary at age 5 was not only predicted by vocabulary at age 4 (standardized coefficient = .62) but also by phonological WM at age 4 (standardized coefficient = .23). This means that phonological WM still affects vocabulary development in children with ID from age 4 to 5. Also, as can be seen in Figure 1b, a lexical bootstrapping effect was found, in that syntax at age 5 could be explained by syntax at age 4 (standardized coefficient = .67) as well as by vocabulary at age 4 (standardized coefficient = .24).

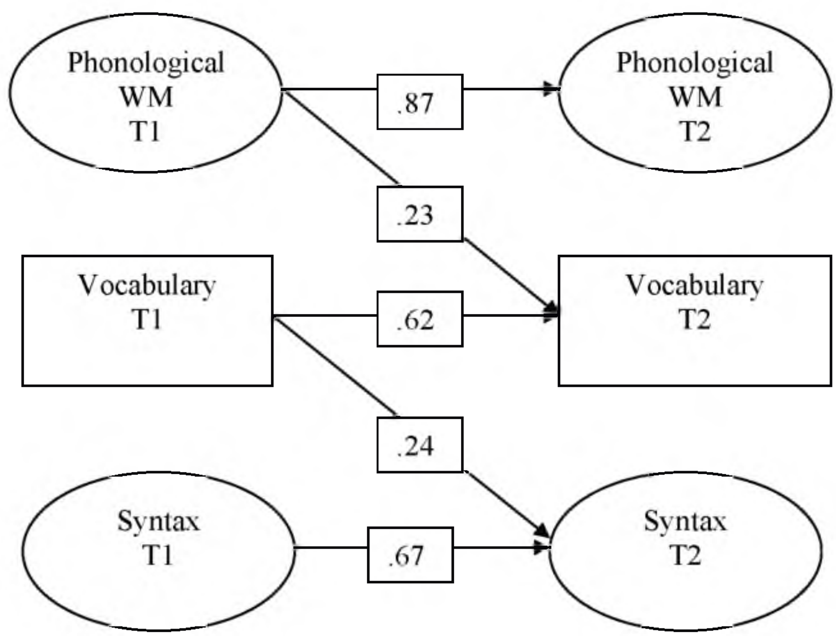
For the typically developing children, the model explained 10% of the variance in phonological WM. For vocabulary and syntax, explained variance was 39%, and 22%, respectively. In comparison, for the children with ID the model explained 75% of the variance in phonological WM. Explained variance for vocabulary and syntax was 64%, and 77%, respectively.

Table 2. *Goodness of Fit Statistics for the SEM Models for the Two Groups*

| Model | $\chi^2$ | df | *p* | GFI | AGFI | CFI | NFI | RMSEA | SRMR |
|---|---|---|---|---|---|---|---|---|---|
| Typically developing children | 5.94 | 12 | .919 | .95 | .92 | 1.00 | .95 | .00 | .10 |
| Children with ID | 8.59 | 10 | .572 | .94 | .88 | 1.00 | .98 | .00 | .04 |




a. Typically developing children




b. Children with ID

*Figure 1.* Final SEM model of the longitudinal relationships between phonological WM, vocabulary, and syntax for the typically developing children and the children with ID.

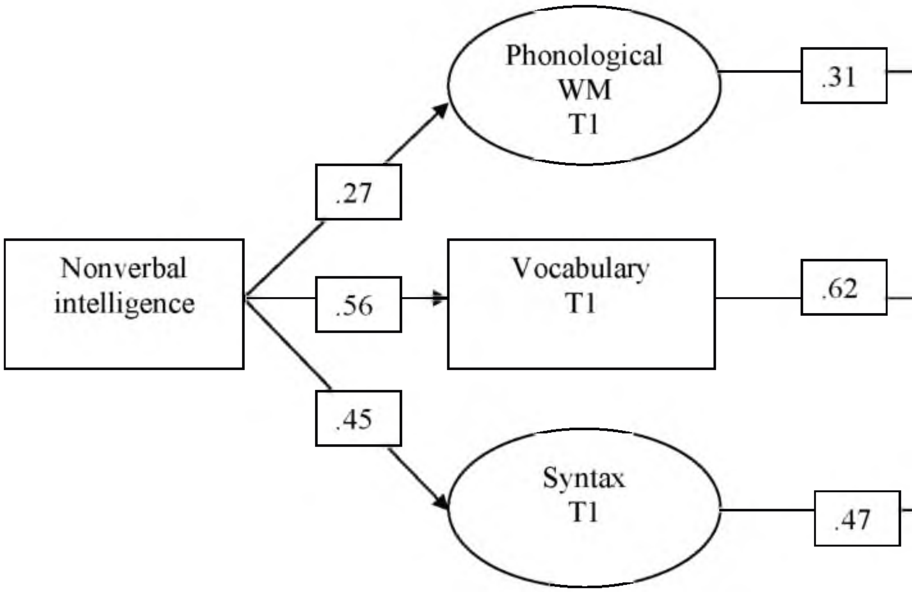
*The role of nonverbal intelligence*

To investigate the second research question, on the role of nonverbal capacity on the language development from age 4 to 5, nonverbal intelligence was added to the models for both groups. Figure 2 shows the final SEM model for the typically developing children (2a) and the children with ID (2b). The goodness-of-fit indices of both models can be found in Table 3. The different indices suggested that the models were acceptable for both groups. All relationships presented in Figure 2 were significant with $p < .05$. For the typically developing children, adding nonverbal intelligence to the model did not result in a change in the structural relationships between phonological WM, vocabulary, and syntax. Again, the development of the three variables was autonomous, with each variable (e.g., phonological WM, vocabulary, and syntax) at age 4 predicting the same variable at age 5. Nonverbal intelligence predicted phonological WM (standardized coefficient = .27), vocabulary (standardized coefficient = .56), and syntax (standardized coefficient = .45) at age 4, but not at age 5. For the children with ID, however, adding nonverbal intelligence to the model did change the structural relationships between phonological WM, vocabulary, and syntax. First, all variables at age 5 were most strongly predicted by the same variables at age 4. However, nonverbal intelligence also predicted all variables at both age 4 and 5. Finally, the lexical bootstrapping effect remained, in that syntax at age 5 was also predicted by vocabulary at age 4 (standardized coefficient = .20).

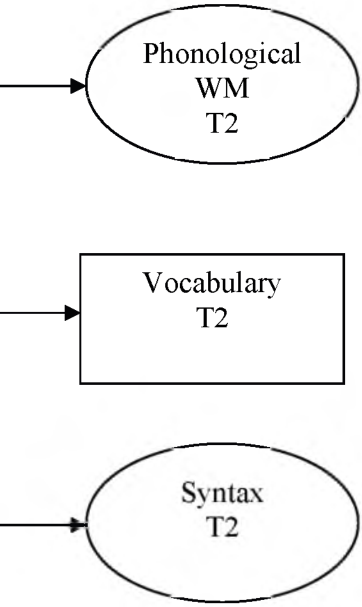
For the typically developing children, the model explained 10% of the variance in phonological WM, 39% of the variance in vocabulary, and 22% in syntax. In addition, the percentage of explained variance in phonological WM, vocabulary, and syntax at age 4 was 7, 21, and 31, respectively. In comparison, for the children with ID the model explained 79% of the variance in phonological WM, 72% of the variance in vocabulary, and 81% in syntax. In addition, the percentage of explained variance in phonological WM, vocabulary, and syntax at age 4 was 51, 51, and 47, respectively.

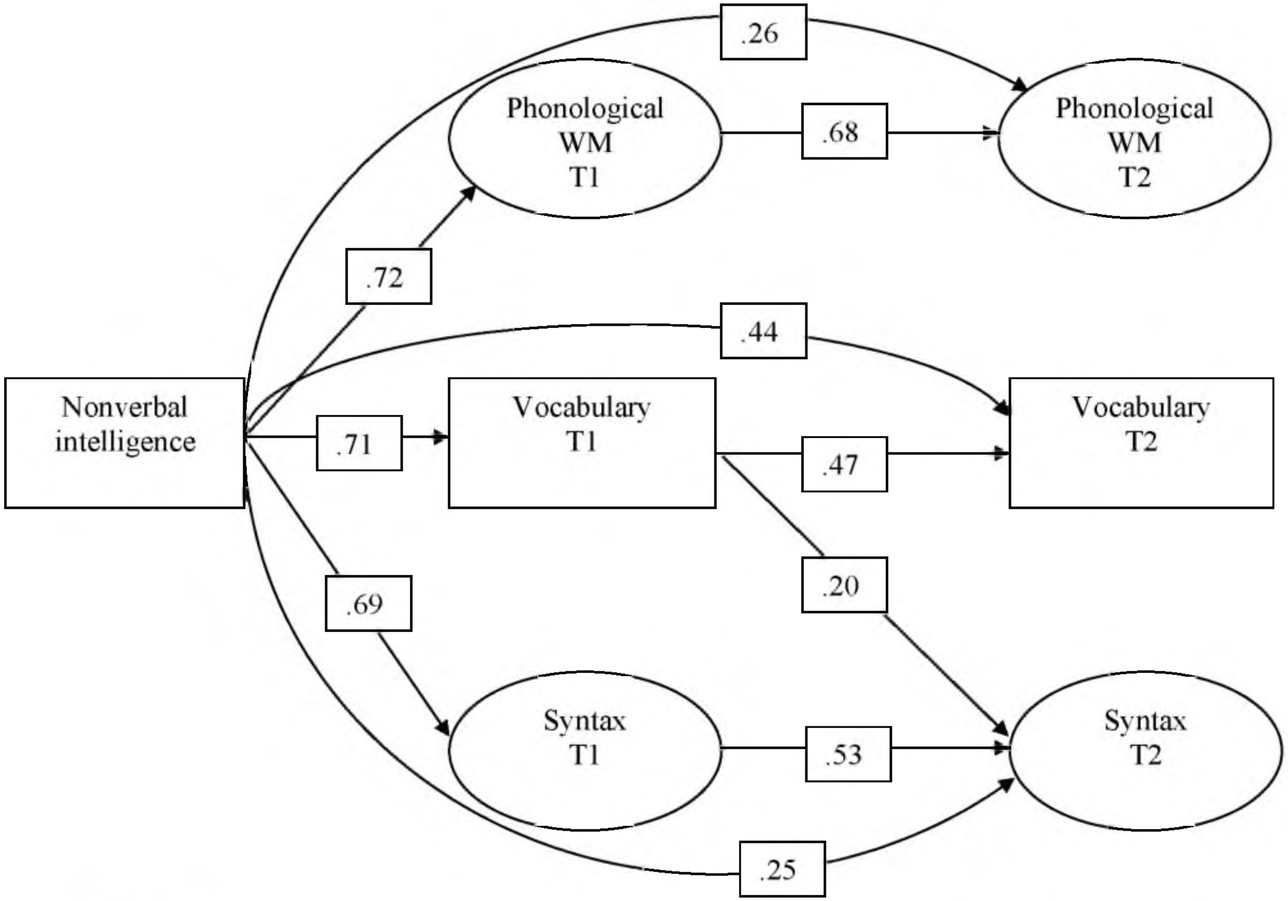
Table 3. *Goodness of Fit Statistics for the SEM Models with Nonverbal Intelligence for the Two Groups*

| Model | $\chi^2$ | df | $p$ | GFI | AGFI | CFI | NFI | RMSEA | SRMR |
|---|---|---|---|---|---|---|---|---|---|
| Typically developing children | 8.27 | 11 | .689 | .95 | .86 | 1.00 | .94 | .00 | .10 |
| Children with ID | 5.29 | 6 | .508 | .97 | .86 | 1.00 | .99 | .00 | .01 |




a. Typically developing children


Phonological
WM
T2
Vocabulary
T2
Syntax
T2




b. Children with ID

*Figure 2.* Final SEM model of the longitudinal relationships between nonverbal intelligence, phonological WM, vocabulary, and syntax for the typically developing children and the children with ID.

## Discussion and Conclusions

This study examined the influence of cognitive factors on the language development of children with ID and typically developing children. The aim was to describe how phonological WM affects the development of vocabulary and syntax and to find out what the role is of nonverbal capacity on the language development from age 4 to 5. As expected, children with ID were far behind their typically developing peers on nonverbal intelligence, phonological WM, vocabulary, and syntax, a finding that is in line with previous research (e.g., Kaiser et al., 2001; Roberts et al., 2007). Even when nonverbal intelligence was taken into account, children with ID still showed significant delays on phonological WM, and syntax. No significant differences, however, were found for vocabulary at both ages 4 and 5. This means that although children with ID have lower vocabulary levels, controlling for intellectual level results in non-significant differences on vocabulary between the two groups. This finding suggests that the vocabulary levels of the children with ID are in pace with their mental level, but that both phonological WM and syntax level are below their mental level.

When studying the role of phonological WM in longitudinal language development, two different models were found for the two groups. For the typically developing children no effect from phonological WM on vocabulary or syntax development from age 4 to 5 was found. Also, no structural relationships were found between vocabulary and syntax development from age 4 to 5. This means that for these children, the development of phonological WM, vocabulary and syntax is quite autonomous. Previous research has also shown this emerging modularity, in which different language domains become more autonomous during development (Jones Moyle et al., 2007). This means that, while during early language development tight relationships exist between the different language domains, from a certain point in development these domains dissociate. For example, research has shown both lexical and syntactic bootstrapping in typical language development (Dionne et al., 2003), however, after the age of 3;6 years no cross-lagged relationships have been found between lexical and grammatical development (Jones Moyle et al., 2007).

For the children with ID, who are delayed in language development, a different model was found. First, results showed a positive relationship between phonological WM at age 4 and vocabulary at age 5. This indicates that good phonological WM skills at age 4 will have a positive influence on vocabulary skills one year later. Previous research has also found this influence of phonological WM on vocabulary development in both typical and atypical language development (Christophe et al., 1997; Gathercole & Baddeley, 1990; Jarrold et al., 2004). The results also imply that difficulties in phonological WM may have a restrictive influence on vocabulary growth. This is consistent with a study of Jarrold et al. (2004) in which it was found that children who have difficulties in phonological WM need more time to develop vocabulary.

Furthermore, evidence was found for lexical bootstrapping effects in children with ID, because a positive relationship was found between vocabulary at age 4 and syntax at age 5. This relationship indicates that good vocabulary skills at age 4 increase the chance of better syntax skills at age 5. This finding is consistent with previous research with younger typically developing children (Bates & Goodman, 1997; Marchman & Bates, 1994). However, in typical language development lexical bootstrapping only appeared before the age of 2;6 years, after which syntactic bootstrapping effects were observed (Miolo et al., 2007). The children with ID in the present study had a developmental level of 2;8 years at the first measurement point, from which it could be expected that syntactic bootstrapping effects would be observed, but they were not. This finding points to a prolonged duration of lexical bootstrapping effects in the language development of children with ID. In a study of Jones Moyle et al. (2007) comparable results were found for late-talking children with normal intelligence levels.

The presence of lexical bootstrapping effects at this point of development could mean that children with ID show a prolonged effect of the ‘critical mass’ phenomenon (Bates & Goodman, 1997; Marchman & Bates, 1994), with vocabulary development driving syntactic development. This continuation of the lexical bootstrapping effect after children had already reached the critical mass of 50-100 productive words could indicate that children with ID simply need a larger critical mass of vocabulary and thus more linguistic models for syntactic development to be initiated. This can be caused by a less adequate storage of vocabulary and therefore less elaborate and more superficially organized mental lexicons in children with ID (Leonard & Deevy, 2004). Another explanation for the prolonged lexical bootstrapping effect in children with ID can be that they find it more difficult to use syntactic cues to interpret word meaning, which will hinder syntactic knowledge to bootstrap lexical development (Dionne et al., 2003; Jones Moyle et al., 2007). Using syntactic structures to infer word meaning may be further hindered by difficulties in phonological WM, which will make it harder to comprehend sentences and to abstract structured patterns of the verbal sequences heard (Conway & Pisoni, 2008; Miolo et al., 2005).

To answer the second research question, with regard to the role of nonverbal capacity on language development, nonverbal intelligence was included in the model as an independent variable. For the typically developing children, this did not change the structural relationships between phonological WM, vocabulary, and syntax. Nonverbal intelligence was only predictive of these three variables at age 4 and not at age 5. In contrast, for the children with ID, nonverbal intelligence was predictive of phonological WM, vocabulary, and syntax at both age 4 and 5. The lexical bootstrapping effect remained after including nonverbal intelligence, showing the tight relationship between vocabulary and syntax. However, no relationship was found between phonological WM at age 4 and vocabulary at age 5, which indicates that nonverbal intelligence has a stronger influence on vocabulary development than phonological WM.

Nonverbal intelligence thus seems very important in the ongoing language development of children with ID. This has an important implication for clinical practice, because early language interventions should not only focus on linguistic aspects but also include cognitive predictors like concept development and working memory. Also, in order for children to learn to attach the heard sound sequences to perceived objects, they need to interact in joint attention with adults and understand their communicative intentions (Tomasello, 2003; Tomasello & Farrar, 1986). Especially children with autism experience difficulties in the ability to follow others' gaze cues and in establishing and maintaining joint attention with others (Landa, 2007; Mundy, Sigman, & Kasari, 1990). An intervention program that targets nonverbal communication skills like vocalizations, eye gaze, and gestures, through joint attention interactions, is prelinguistic milieu teaching (PMT) (Warren, Yoder, Gazdag, Kim, & Jones, 1993). In this approach, intervention is grounded in daily social routines, such as planning the day, turn-taking games, and storybook reading. Communicative partners are taught to follow the child's lead, to prompt specific skills, and to model the target skills when needed. PMT has been found to be particularly effective for children who do not yet demonstrate emerging language, and who need to increase prelinguistic communication skills like gestures and vocalizations (Warren, Bredin-Oja, Fairchild, Finestack, Fey, & Brady, 2006).

The interdependence of language domains in early language development indicates that interventions targeted at this development should give attention to all language domains. An immersive intervention designed to stimulate early language, basic communication, and early literacy, while taking the individual differences between children with ID (e.g., nonverbal intelligence level, and phonological WM) into account, can result in significant learning gains (Van der Schuit et al., 2010; Van der Schuit, Segers, Van Balkom, &

Verhoeven, 2011). Stimulating children's language and early literacy by developing their vocabularies and using augmentative and alternative communication (AAC) within a transactional approach which draws upon experiential learning, anchored instruction, and interactive storybook reading, resulted in greater vocabulary and syntax development for the children in the intervention group than children in a control group (Van der Schuit et al., 2011).

It should be acknowledged that the present study has some limitations. First, in studying cognitive factors that could influence language development, we focused on general nonverbal intelligence and the phonological aspect of WM. However, other factors could play an equally important role in language development. For instance, working memory also comprises the central executive, which serves as an attentional controller. Therefore, future research should also include tasks to assess attention and executive functioning in children with ID. Furthermore, standardized testing sessions require a certain level of motivation in order for children to perform well. Children with ID often have limited motivation or perseverance to achieve at their best during testing situations. Moreover, behavior of young children in new situations with unfamiliar adults is not always representative of the child's typical behavior (McLean & Crais, 1996). Standardized testing should thus be accompanied by more naturalistic testing situations in which language abilities of children can be observed (e.g., MLU and conversational skills). Future longitudinal studies should include a second control group of typically developing children with the same developmental age as the children with ID, to further investigate the influence of cognitive factors on the language development of children with ID and typically developing children. Also, longitudinal studies need to follow children with ID for a prolonged period of development, to investigate whether lexical bootstrapping effects remain for these children or whether, and at what developmental level, syntactic bootstrapping effects can be observed.

To conclude, the results of the present study suggest that phonological WM is predictive of vocabulary from age 4 to 5 in children with ID. However, when nonverbal intelligence level is taken into account, this relationship disappears, illustrating the importance of nonverbal intelligence for the language development of young children with ID. The role of nonverbal capacity is larger in the language development of children with ID than it is for typically developing children. Furthermore, children with ID show a prolonged lexical bootstrapping effect in their language development, pointing to a continuation of the 'critical mass' phenomenon, with children with ID requiring a larger critical mass of vocabulary for syntactic development to be initiated. Early language interventions should thus focus on both cognitive and linguistic factors of language development.

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# Appendices

**Appendix A.** *Correlations for Structural Equation Modeling Analyses for the Typically Developing Children*

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 1 | Vocabulary T1 | 1.00 | | | | | | |
| 2 | Syntax T1 | .652 | 1.00 | | | | | |
| 3 | Phonological WM T1 | .394 | .536 | 1.00 | | | | |
| 4 | Vocabulary T2 | .634 | .389 | .379 | 1.00 | | | |
| 5 | Syntax T2 | .404 | .487 | .389 | .477 | 1.00 | | |
| 6 | Phonological WM T2 | .363 | .331 | .334 | .269 | .363 | 1.00 | |
| 7 | Nonverbal intelligence | .453 | .560 | .267 | .376 | .265 | .295 | 1.00 |

**Appendix B.** *Correlations for Structural Equation Modeling Analyses for the Children with ID*

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 1 | Vocabulary T1 | 1.00 | | | | | | |
| 2 | Syntax T1 | .824 | 1.00 | | | | | |
| 3 | Phonological WM T1 | .652 | .838 | 1.00 | | | | |
| 4 | Vocabulary T2 | .790 | .645 | .650 | 1.00 | | | |
| 5 | Syntax T2 | .829 | .858 | .753 | .805 | 1.00 | | |
| 6 | Phonological WM T2 | .655 | .754 | .870 | .701 | .791 | 1.00 | |
| 7 | Nonverbal intelligence | .711 | .688 | .716 | .777 | .761 | .752 | 1.00 |

# Home Literacy Environment of Preschool Children with Intellectual Disabilities*

*Chapter 4*


**Abstract**

*Background:* For preschool children, the home literacy environment (HLE) plays an important role in the development of language and literacy skills. As there is little known about the HLE of children with ID, the aim of the present study was to investigate the HLE of children with ID in comparison to children without disabilities.

*Method:* Parent questionnaires concerning aspects of the HLE were used to investigate differences between 48 children with ID, 107 children without disabilities of the same chronological age (CA), and 36 children without disabilities of the same mental age (MA). Furthermore, for the children with ID, correlations were computed between aspects of the HLE and children's nonverbal intelligence, speech intelligibility, language, and early literacy skills.

*Results and Conclusions:* From the results of the MANOVA it could be concluded that the HLE of children with ID differed from that of children in the CA group on almost all aspects. When compared to children in the MA group, differences in the HLE remained. However, differences mainly concerned child-initiated activities and not parent-initiated activities. Correlation analyses showed that children's activities with literacy materials were positively related with mental age, productive syntax and vocabulary age and book orientation skills. Also, children's involvement during storybook reading was related with their mental age, receptive language age, productive syntax and vocabulary age, book orientation and rapid naming of pictures The amount of literacy materials parents provided, was related to a higher productive syntax age and level of book orientation of the children. Parent play activities were also positively related to children's speech intelligibility. The cognitive disabilities of the children were the main cause of the differences found in the HLE between children with ID and children without disabilities. Parents also adapt their level to the developmental level of their child, which may not always be the most stimulating for the children.


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*This chapter was published as: Van der Schuit, M., Peeters, M., Segers, E., Van Balkom, H., & Verhoeven, L. (2009). Home literacy environment of pre-school children with intellectual disabilities. *Journal of Intellectual Disability Research, 53*, 1024-1037.

## Introduction

Children with intellectual disabilities (ID) are known to be at risk for limited language and literacy development (Abbeduto, Warren, & Conners, 2007; Kaiser, Hester, & McDuffie, 2001). The group is characterized by large variation in kind and severity of the disabilities, but in the vast majority of cases their ID are accompanied by speech and/or language disabilities. These children develop language slower than typically developing children, but seem to follow the same developmental steps (Bates, Dale, & Thal, 1995), thus having language abilities that are at the level of their mental age (Chapman, 1997; Rondal, 2001). Besides cognitive and speech disabilities, the home literacy environment (HLE) may also play an important role in their language and literacy development (Weikle & Hadadian, 2004).

Children develop their early language and literacy skills in the context of their HLE (Scarborough & Dobrich, 1994; Whitehurst & Lonigan, 1998). The HLE is seen as a construct that consists of various interrelated aspects, all influencing the language and literacy development of children (Leseman & de Jong, 1998; Roberts, Jurgens, & Burchinal, 2005). Some aspects are: shared storybook reading and the amount of active engagement of the child during this activity (Justice & Kaderavek, 2002), literacy interest of the child (Frijters, Barron, & Brunello, 2000), the number of reading and writing materials available (Hood, Conlon, & Andrews, 2008), the experiences and activities of the child with literacy materials (Levy, Gong, Hessels, Evans, & Jared, 2006), activities of parents to stimulate children's literacy development (Sénéchal & LeFevre, 2002; Wood, 2002), parents' own literacy materials and activities (Foy & Mann, 2003), the attitudes and beliefs of parents about the importance of early literacy exposure (Weigel, Martin, & Bennett, 2006b), and the expectations of parents regarding their child's literacy development (Lee & Groninger, 1994).

Much research on the HLE of children with disabilities focused on children with physical disabilities (e.g., cerebral palsy (CP)) (Dahlgren Sandberg, 1998; Light & Kelford Smith, 1993). It was shown that these children have limited access to literacy materials (i.e., books, drawing materials) and have fewer opportunities to interact with these materials independently than their peers without disabilities (Light & Kelford Smith, 1993; Peeters, Verhoeven, Van Balkom, & De Moor, 2009). Furthermore, in contrast to parents of children without disabilities, parents of children with physical disabilities mostly dominate the interaction during storybook reading, giving the child fewer opportunities to actively participate in the conversation. This leads to less initiations and more passive responses with yes/no answers of the child (Dahlgren Sandberg, 1998; Light, Binger, & Kelford Smith, 1994; Peeters, Verhoeven, De Moor, Van Balkom, & Van Leeuwe, 2009). The differences that were found between the children with CP and children without disabilities could largely be explained by the physical and accompanying disabilities of the children and not by differences in intellectual capacities. Previous studies indicate that for children with ID, the HLE is different from that of typically developing children (Weikle & Hadadian, 2004). These children have fewer literacy materials to interact with than their peers without ID (Marvin, 1994; Trenholm & Mirenda, 2006), are read to less frequently, and during storybook reading interactions, the main behaviors of their parents are pointing to and/or labeling pictures. Higher-order reading interactions, like asking what would happen next or to re-tell a story, are less frequently used during storybook reading (Trenholm & Mirenda, 2006).

The research described above mostly contained groups of children with disabilities that were either highly heterogeneous in both age and disabilities (cf., Marvin, 1994; Weikle & Hadadian, 2003) or focused only on a very specific subgroup of children, like children with Down syndrome (Trenholm & Mirenda, 2006). While early literacy skills are important predictors of later reading development (Sénéchal & LeFevre, 2002), no research has been carried out on preschool children with ID. Furthermore, no studies have investigated whether the HLE of children with ID differed from children without disabilities with the same MA, thus ignoring the fact that lower developmental age may explain the differences found between the HLE of children with and without disabilities of the same chronological age (CA).

In the present study, we therefore compared preschool children with ID to two comparison groups of children without disabilities: one comparable on CA and one comparable on MA. Also, taking into account the heterogeneity of the ID group, the relationships between aspects of the HLE and children's nonverbal intelligence, speech intelligibility, language, and early literacy skills were examined. The following research questions were addressed:

1. What and of what nature are the differences between the HLE of children with ID and CA comparison children without disabilities?
2. What and of what nature are the differences between the HLE of children with ID and MA comparison children without disabilities?
3. Within the group of children with ID, to what extent do relationships exist between aspects of the HLE and children's nonverbal intelligence, speech intelligibility, language, and early literacy skills?

With regard to the first question, we expected the HLE of children with ID to be both quantitatively and qualitatively different from the HLE of their peers without disabilities, because children with ID will probably have fewer opportunities to manipulate books and writing materials independently and to be less actively engaged during storybook reading (cf. Marvin, 1994; Marvin & Wright, 1997; Peeters, Verhoeven, De Moor, et al., 2009; Peeters, Verhoeven, Van Balkom, et al., 2009; Trenholm & Mirenda, 2006). We also expected parents of children with ID to engage less frequently in emergent literacy activities with their children, and to have lower expectations for their child's literacy development. Regarding the second research question, differences were expected between children with ID and children without disabilities of the same MA. These differences were again expected to be found in the child's own activities with literacy materials, but not in the activities parents provided to stimulate their child's literacy development, as parents are known to adapt their communication to the developmental level of their child (Kaiser et al., 2001). Concerning the third question, the expectation was that children's nonverbal intelligence, speech intelligibility, language, and early literacy skills were all related in some way to one or more aspects of the HLE, given that these relationships were previously found in typically developing children (Frijters et al., 2000; Weigel, Martin, & Bennett, 2006a). For example, children's knowledge about features of printed language (i.e., book orientation) was expected to be related with the literacy materials parents provided for their children (Weigel et al., 2006a).

## Method

*Participants*

Participants were preschool children with ID, CA comparison children without disabilities, and MA comparison children without disabilities. Parents or guardians of all children gave informed consent at study entry. Parents of 48 children with ID (64% of approached parents), 107 CA comparison children without disabilities (85%) and 36 MA comparison children without disabilities responded to the questionnaires (76%).

The children with ID attended special day-care centers and schools for preschool children with ID in the Netherlands. Inclusion criteria for these children were: a chronological age between three and five years, a nonverbal IQ between 50 and 85, no severe hearing or vision loss, and Dutch as the primary language at home. This group consisted of 35 boys and 13 girls (IQ range 49-84, $M$ = 58, $SD$ = 9.88): 5 with Down or another syndrome, 10 with an accompanying disorder like autism or ADHD, 4 with brain damage or epilepsy, 2 with dyspraxia, 2 with a sensory impairment, 3 with a psychomotor retardation, and 22 with a yet unknown etiology of their ID. Parents of 27 children reported their child to use symbols besides or instead of natural speech to communicate; 12 of these children had access to these symbols during storybook reading.

The children without disabilities were recruited from regular day-care centers and schools in the Netherlands. These children had a chronological age between three and five years, had no known impairments, and Dutch as the primary language at home. The CA group consisted of 52 boys and 55 girls. The MA group consisted of 19 boys and 17 girls. Eleven children (six boys and five girls) with a very low MA (below 29 months) were removed from the ID group in order to make the ID group comparable on MA to the MA group. The characteristics of the ID, CA, and MA group used in the analyses can be found in Table 1.

Table 1. *Group Characteristics*

| | CA comparison | | | MA comparison | | |
|---|---|---|---|---|---|---|
| | ID ($n$ = 48) | CA ($n$ = 107) | $p$ | ID ($n$ = 37 ) | MA ($n$ = 36) | $p$ |
| Chronological age | 54 months ($SD$ = 9.7) | 55 months ($SD$ = 2.6) | .71[b] | 58 months ($SD$ = 7.7) | 36 months ($SD$ = 1.9) | .01[b**] |
| Mental age | - | - | - | 38 months ($SD$ = 6.7) | 40 months ($SD$ = 5.1) | .18[b] |
| Gender | 35 boys; 13 girls | 52 boys; 55 girls | .01[c**] | 29 boys; 8 girls | 19 boys; 17 girls | .02[c*] |
| SES[a] | 4.7 (range: 1.5-7) | 5.0 (range: 2-7) | .49[c] | 4.5 (range: 1.5-7) | 5.6 (3.5-7) | .11[c] |
| Age of the parent who filled in the questionnaire | 37.5 years ($SD$ = 5.1) | 36.6 years ($SD$ = 4.7) | .26[b] | 38.4 years ($SD$ = 5.2) | 37.2 ($SD$ = 2.9) | .22[b] |

[a]Based on parental education; 1 = no education, 7 = academic education

[b]Results from $t$ test

[c]Results from chi-square test

$^{*}p < .05$, $^{**}p < .01$

*Materials*

The materials used in this study consisted of five parent questionnaires regarding the HLE and seven standardized tasks to assess children's nonverbal intelligence, speech intelligibility, language, and early literacy skills.

*HLE parent questionnaires.* We used the five HLE parent questionnaires from Peeters, Verhoeven, De Moor, et al. (2009) and Peeters, Verhoeven, Van Balkom, et al. (2009) addressing (a) child's literacy interest, (b) child's activities during storybook reading, (c) materials and parental activities for child literacy development, (d) parents' own literacy materials and activities, and (e) parents' expectations of their child's literacy development.

For the first four questionnaires, factor analyses were performed using Principal Axis Factoring (PAF) with promax rotation (cf. Peeters, Verhoeven, De Moor, et al., 2009; Peeters, Verhoeven, Van Balkom, et al., 2009). The individual items of the four parent questionnaires and the results of the factor analyses can be found in Appendix A. The results of the factor analyses were comparable to Peeters, Verhoeven, Van Balkom, et al., (2009), indicating that the questionnaires were reliable, and valid measurements of the HLE.

The fifth questionnaire consisted of two multiple-choice items concerning parents' expectations about their child's literacy development (i.e., reading and writing level) at the end of elementary school, i.e., the end of 6th grade. These items were analyzed with Chi-square tests.

*Standardized tasks.*

*Intelligence.* Nonverbal intelligence was measured by administering the Revised Snijders-Oomen Nonverbal Intelligence Test (SON-R 2 ½ - 7) (Tellegen et al., 2005), a standardized test (Cronbach's alpha = .90) that measures nonverbal intelligence without using spoken or written language. The test is divided in a reasoning scale (Situations, Categories and Analogies) and a performance scale (Patterns, Mosaics and Puzzles). The six subtests are composed of 14 to 17 items with an increasing level of difficulty. For the reasoning score the reliability has a mean value of .84 and the reliability of the performance score is on the average .85.

*Speech intelligibility.* In a Pseudo word articulation task (Verhoeven, 2006; Cronbach's alpha = .95.) the child was instructed to repeat 40 pseudo words of increasing difficulty. Words were presented one at a time by a recorded voice. The task was terminated when the child had made five successive errors.

*Receptive language.* Receptive language was assessed by the Dutch version of the Reynell Test for Language Comprehension (Van Eldik et al., 2004; Cronbach's alpha = .90), a standardized test designed to measure language comprehension (passive vocabulary and comprehension of grammatical structures) in children from 1;2 to 6;3 years of age. The test is divided into 12 sections, composed of 3 to 14 items with an increasing level of difficulty.

*Productive language.* Productive language was assessed by the Schlichting Test for Language Production (Schlichting et al., 2003). The test is divided into two subtests. The subtest for sentence development (Cronbach's alpha = .85 ) measures the productive syntactic development of children by eliciting syntactic structures of different difficulty (e.g., one-, two-, or three-word sentences) from the child through toys and pictures. The subtest for word development (Cronbach's alpha = .87) measures the productive vocabulary of a child by means of naming concrete objects and pictures.

*Book orientation* (Van Kuyk & Verhoeven, 1996; Cronbach's alpha = .80). On the basis of a book children had to answer 24 questions concerning knowledge about features of printed language (e.g., point at the front of the book, show the reading direction, point to letters).

*Auditory discrimination.* This task consisted of 3 training and 20 test items (Peeters, 2006; Cronbach's alpha = .87). Children were presented with two pictures of sound-related, one-syllable words. The examiner named the pictures, and then asked the child to point to one of the pictures, thus having them discriminate between words like bel [bell] and bal [ball] or nat [wet] and mat [mat].

*Rapid naming pictures.* A standardized subtest of the Dutch SLI Screening Test for Rapid Naming of Pictures was administered (Verhoeven, 2006; Cronbach's alpha = .95). This task consisted of five different pictures (representing a duck, glasses, shoe, house and comb) depicted in four columns of 30 pictures each, yielding a total number of 120 pictures. The child was asked to name as many pictures as fast as possible and as correctly as possible in a vertical direction (i.e., column by column) during one minute.

*Procedure*

The parent questionnaires were sent to the parents via the day-care centers or schools, asking the parent reading most often to the child to fill in the questionnaires. The child variables were assessed by individually testing the children during the time they visited the day-care centre or school. Assessments were carried out in a quiet room by an instructed examiner. The Schlichting Test for Productive Language was always preceded by the Reynell Test for Receptive Language. Instructions were given verbally, in a non-verbal way by gestures or a combination of both, depending on the child's communicative abilities. For the Nonverbal Intelligence Test, instructions were also given through demonstration by the examiner. Communication could be adapted to the particular child, which allowed for a natural and stimulating contact. Moreover, after each item the child received feedback on his or her performance. If necessary, the examiner demonstrated the correct solution to the child. For the Reynell Test for Receptive Language and the Schlichting Test for Productive Language, answers in sign language were accepted.

Age equivalents that corresponded with the child's total scores on the tests for nonverbal intelligence, receptive language, and productive language were obtained by using the norms from the test manual.

*Statistical Analyses*

After the factor analyses of the parent questionnaires were performed, items with salient loadings (>.30) on the factors were converted to Z-scores for all groups. Next, for each factor a composite score was computed, consisting of the averaged standard score of the items with salient loadings on the factor. Cronbach's alpha values were also calculated for each factor. Then, descriptive statistics were obtained for all groups, followed by Multivariate analyses of variance (MANOVAs) to investigate differences between the ID and CA group, and next between the ID and MA group. Also, separate composite scores were computed for the children with ID based on the average Z-scores for the group of children with ID only. To examine the relationships between HLE and children's nonverbal intelligence, speech intelligibility, language, and early literacy skills, Pearson correlations were computed between the composite scores of the factors and the children's test scores.

## Results

*Comparison with children without disabilities of the same CA*

The first research question was concerned with the comparison of the ID and CA groups. Results (see Table 2) showed an overall effect for group, meaning that there were differences between the two groups on aspects of the HLE, Wilks' Lambda = .432, $F(15, 139) = 12.19$, $p < .001$, and $\eta_p^2 = .57$. No differences between the groups were found for the factors: Parent play activities, Parent own book reading, Parent magazine reading, and Parent newspaper reading. The children with ID had lower scores than the CA group on all other factors ($p < .05$), with the exception of Book orientation. Children with ID seemed to dominate the book reading interaction more than the CA group.

Table 2. *Descriptive Statistics of the Home Literacy Factors for the Group of Children with ID (n = 48) and the CA Group (n = 107)*

| | ID | | CA | | | | |
|---|---|---|---|---|---|---|---|
| HLE Factors | *M* | *SD* | *M* | *SD* | *F* | $\eta_p^2$ | *p* |
| Child's writing activities | -.74 | .86 | .33 | .54 | 87.76 | .37 | .001*** |
| Child's storybook reading interest | -.56 | 1.07 | .25 | .63 | 34.50 | .18 | .001*** |
| Child's activities with literacy materials | -.20 | .66 | .09 | .58 | 7.48 | .05 | .007** |
| Story orientation activities | -.55 | .56 | .25 | .59 | 63.65 | .29 | .001*** |
| Book orientation activities | .29 | .94 | -.13 | .65 | 10.63 | .07 | .001*** |
| Picture orientation activities | -.34 | 1.11 | .15 | .67 | 11.46 | .07 | .001*** |
| Word orientation activities | -.43 | .75 | .19 | .83 | 19.49 | .11 | .001*** |
| Provision of literacy materials | -.18 | .61 | .08 | .57 | 6.86 | .04 | .010* |
| Parent storybook reading interest | -.37 | 1.02 | .17 | .66 | 15.12 | .09 | .001*** |
| Parent literacy mediation | -.36 | .69 | .16 | .63 | 21.13 | .12 | .001*** |
| Parent play activities | .03 | .77 | -.01 | .85 | .08 | .00 | .777 |
| Parent book reading | -.06 | .70 | .03 | .69 | .59 | .00 | .443 |
| Parent email use | -.36 | 1.16 | .16 | .77 | 10.75 | .07 | .001*** |
| Parent magazine reading | -.17 | .95 | .07 | .80 | 2.66 | .02 | .105 |
| Parent newspaper reading | -.14 | .85 | .07 | .81 | 1.89 | .01 | .172 |

* $p < .05$ (2-tailed); ** $p < .01$ (2-tailed); *** $p < .001$ (2-tailed)

Parents of children with ID had lower scores on the factors related to their activities than the parents of the CA group. Regarding parents' expectations for their child's reading level at the end of elementary school, again significant differences between the group of children with ID and the CA group were found, $\chi^2$ (5, $N$ = 155) = 93.70, $p < .001$, and eta = .74.[1] Most parents of children without disabilities had high expectations for their child's reading level, i.e., they expected their child to be able to read easy texts (6%) or to read books independently (85%) at the end of elementary school. Only 2% of these parents expected their child to be able to read with pictograms, letters or words and 7% of the parents did not know what to expect for their child's literacy skills at the end of elementary school. In contrast, parents of children with ID often reported that they did not know what to expect of their child's future reading level (69%). If parents had expectations these were generally lower, i.e.

[1]The results of this Chi-square should be interpreted with caution, since more than 20% of the cells have expected cell frequencies less than 5 and/ or the minimum expected cell frequency is less than 1.

they expected their child to be able to read with pictograms (11%), letters (2%), or words (6%). Only 4% expected their child to be able to read easy texts and 8% of the parents expected their child to be able to read books independently. None of the parents of the children with ID or the CA group expected their child not to be able to read at the end of elementary school.

For the writing levels of the children at the end of elementary school, parents' expectations showed the same pattern, $\chi^2$ (5, $N$ = 155) = 95.80, $p$ < .001, and eta = .77.[1] Parents of children with ID had no expectations (73%) or lower expectations about their child's writing level at the end of elementary school, i.e., they expected their child to be unable to write (2%), to be able to write letters (6%) or words (8%). Only 2% of the parents of children with ID expected their child to be able to write simple texts and 8% of the parents expected their child to be able to write longer texts. Most of the parents of children without disabilities had high expectations for their child's writing level, i.e., they expected their child to be able to write longer texts (80%) or simple texts (10%). Only 3% of these parents had low expectations for the writing level of their child and 7% of the parents had no expectations.

*Comparison with children of the same MA*

The second research question concerned the comparison of the children with ID and the MA group. The results can be found in Table 3. Again, significant differences in the HLE between these two groups were found, Wilks' Lambda = .313, $F$(15, 57) = 8.33, $p$ < .001, and $\eta_p^2$ = .69. The differences between the ID and MA group were similar as those between the ID and CA group, however, no differences were found in comparing the ID group to the MA group for the following factors: Child's activities with literacy materials, Word orientation activities, Provision of literacy materials and Parent literacy mediation.

Table 3. *Descriptive Statistics of the Home Literacy Factors for the Group of Children with ID (n = 37) and the MA Group (n = 36)*

| | ID | | MA | | | | |
|---|---|---|---|---|---|---|---|
| HLE Factors | *M* | *SD* | *M* | *SD* | *F* | $\eta_p^2$ | *p* |
| Child's writing activities | -.31 | .87 | .32 | .57 | 13.49 | .16 | .001*** |
| Child's storybook reading interest | -.42 | 1.01 | .43 | .48 | 20.92 | .23 | .001*** |
| Child's activities with literacy materials | .02 | .66 | -.03 | .60 | .11 | .00 | .740 |
| Story orientation activities | -.30 | .56 | .31 | .63 | 19.35 | .21 | .001*** |
| Book orientation activities | .31 | .84 | -.32 | .52 | 14.58 | .17 | .001*** |
| Picture orientation activities | -.21 | .99 | .21 | .67 | 4.49 | .06 | .038* |
| Word orientation activities | .12 | .98 | -.12 | .64 | 1.57 | .02 | .215 |
| Provision of literacy materials | .03 | .69 | -.03 | .44 | 0.15 | .00 | .697 |
| Parent storybook reading interest | -.28 | .93 | .29 | .59 | 9.89 | .12 | .002** |
| Parent literacy mediation | -.06 | .74 | .06 | .56 | 0.58 | .01 | .447 |
| Parent play activities | -.10 | .82 | .10 | .82 | 1.07 | .02 | .306 |
| Parent book reading | -.08 | .74 | .08 | .68 | .90 | .01 | .346 |
| Parent email use | -.39 | 1.04 | .40 | .61 | 15.37 | .18 | .001*** |
| Parent magazine reading | -.15 | .95 | .15 | .77 | 2.10 | .03 | .152 |
| Parent newspaper reading | -.27 | .85 | .28 | .79 | 8.10 | .10 | .006** |

* $p < .05$ (2-tailed); ** $p < .01$ (2-tailed); *** $p < .001$ (2-tailed)

The parents of children with ID showed the same expectation pattern as described in the previous paragraph, with similar results for expectations for their child's reading level $\chi^2$ (4, $N = 73$) = 50.20, $p < .001$, and eta = .81[1] and writing level $\chi^2$ (4, $N = 73$) = 55.47, $p < .001$, and eta = .83[1] at the end of elementary school.

*Relationships between child variables and the HLE*

The third research question was concerned with the relationships between aspects of the HLE and children's nonverbal intelligence, speech intelligibility, language, and early literacy skills within the group of children with intellectual disabilities. In Table 4 the mean scores and standard deviations of the children with ID on the standardized tasks can be found.

Table 4. *Descriptive Statistics (Means and Standard Deviations) of the Standardized Tasks for the Group of Children with ID (n = 48)*

| *Standardized task* | *M* | *SD* |
|---|---|---|
| Mental age (months) | 34.8 | 8.2 |
| Receptive language age (months) | 33.3 | 9.0 |
| Productive syntax age (months) | 30.1 | 10.5 |
| Productive vocabulary age (months) | 32.4 | 10.5 |
| Auditory discrimination | 11.8 | 5.2 |
| Speech intelligibility | 1.2 | 2.5 |
| Book orientation | 1.6 | 2.7 |
| Rapid naming pictures | 13.0 | 12.5 |

Table 5 shows the correlations between the child variables and aspects of the HLE. As can be seen, children that were engaged in more activities with literacy materials had a higher mental age, productive syntax age, productive vocabulary age, and higher book orientation skills (all *p*s $< .05$). Furthermore, the more involved children were during storybook reading, the higher their mental age, receptive language age, productive syntax age, productive vocabulary age, book orientation and rapid naming of pictures (all *p*s $< .05$).

The more literacy materials parents provided for their children, the higher the productive syntax age and level of book orientation of the children (all *p*s $< .05$). Parent play activities were also positively related to children's speech intelligibility ($p < .05$).

Table 5. *Pearson's Correlations between HLE Factors and Child Variables for Children with ID (n = 48)*

| HLE Factors | MA | RLA | PSA | PVA | Aud[a] | Art[a] | Book[a] | RAN[a] |
|---|---|---|---|---|---|---|---|---|
| Child's writing activities | .22 | .20 | .08 | .14 | .03 | .24 | .14 | .22 |
| Child's storybook reading interest | .04 | .03 | .18 | -.01 | .05 | -.12 | .27 | .10 |
| Child's activities with literacy materials | .38** | .25 | .31* | .34* | .18 | .04 | .38** | .22 |
| Story orientation activities | .65*** | .60*** | .43** | .52*** | .29 | -.12 | .25 | .29* |
| Book orientation activities | .11 | .06 | -.29 | -.14 | -.16 | -.28 | -.19 | -.22 |
| Picture orientation activities | .21 | .20 | -.05 | .18 | .09 | .09 | .06 | .15 |
| Word orientation activities | .44** | .40** | .13 | .33* | .24 | -.00 | .38** | .18 |
| Provision of literacy materials | .16 | .08 | .35* | .13 | .04 | -.12 | .44** | .11 |
| Parent storybook reading interest | -.00 | -.01 | .13 | -.00 | .03 | -.17 | .16 | .07 |
| Parent literacy mediation | .19 | .19 | -.00 | .25 | .16 | -.10 | .14 | .07 |
| Parent play activities | .08 | .01 | .25 | .01 | .25 | .34* | .01 | .23 |
| Parent book reading | -.12 | -.09 | .24 | .02 | -.12 | -.21 | .26 | .02 |
| Parent email use | -.03 | -.08 | -.14 | -.10 | -.48*** | .21 | -.12 | -.22 |
| Parent magazine reading | .20 | .10 | .23 | .11 | -.04 | .04 | .16 | .16 |
| Parent newspaper reading | -.08 | .02 | -.20 | .09 | .04 | -.24 | -.05 | -.09 |

*Note.* MA = mental age, RLA = receptive language age, PSA = productive syntax age, PVA = productive vocabulary age, AUD = auditory discrimination, ART = speech intelligibility, Book = book orientation, RAN = rapid naming pictures.

[a] partial correlations with chronological age as covariable

* $p < .05$ (2-tailed), ** $p < .01$ (2-tailed), *** $p < .001$ (2-tailed)

## Conclusions and Discussion

In the present study, the HLE of children with ID was compared to that of children without disabilities to find out to what extent there were differences, and if so, of what nature these differences were. First of all, the HLE of children with ID differed in many aspects from that of children without disabilities of the same chronological age. Differences were not only found in activities the children engaged in themselves, but also in the amount of literacy materials that parents provided for their children and in literacy activities parents engaged in with their children. Children with ID had fewer experiences with reading, writing and drawing materials and showed less interest in storybook reading activities than their peers without disabilities. During storybook reading sessions, they were less involved in story, picture and word orientation activities than children without disabilities of the same chronological age; e.g., pointing at pictures, letters or words, asking questions about the story or give comments on the story. These results are in line with previous research (Marvin & Mirenda, 1993; Marvin & Wright, 1997; Peeters, Verhoeven, Van Balkom, et al., 2009).

Furthermore, a comparison was made between the HLE of children with ID and children without disabilities of *the same mental age*. Differences with children of the same mental age mainly concerned the activities the children engage in themselves (e.g., child's writing activities, child's storybook reading interest and story orientation activities) and not parent-initiated activities (e.g., parent literacy mediation and provision of literacy materials). These results indicate that parents adapt their level of communication to the developmental age of their child (cf. Kaiser et al., 2001). It seems that the differences found between children with ID and the MA group were largely caused by the child variables (e.g., cognitive and speech disabilities) of the children with ID. This means that, although parents adapted their HLE practices to the developmental level of their child, the children with ID showed less literacy activities.

A large part of the children with ID was non-speaking (19 children), and this could have influenced the results, since children that do not speak may not give much feedback to parents during storybook reading, resulting in less interactive storybook reading sessions. However, the results remained the same in additional analyses without the non-speaking children, suggesting that the cognitive disabilities and not the speaking abilities of the children were the main cause of the differences found in HLE.

Another difference between the groups concerns the expectations parents have of their child's literacy development. Most parents of children with ID did not know what to expect of their child's future reading and writing level, and if they had expectations, these were generally lower. In contrast, parents of children without disabilities almost all had high expectations for their child's reading and writing level at the end of elementary school (cf. Marvin, 1994; Marvin & Mirenda, 1993; Peeters, Verhoeven, Van Balkom, et al., 2009). The expectations parents have about the literacy development of their children influence this development (Lee & Groninger, 1994), and this also goes for children with ID (Al Otaiba, Lewis, Whalon, Dyrlund, & McKenzie, 2009; Koppenhaver, Evans, & Yoder, 1991). It is therefore important for future research to find out why parents of children with ID do not know what to expect of their child's literacy development, and to focus on how to guide parents in stimulating their child's literacy development in the best possible way.

Another interesting finding of this study is that, although the children with ID scored lower on all aspects of the HLE compared to the CA and the MA group, they scored higher on one factor: Book orientation activities. A higher score on this factor means that children were more active during storybook reading than children without disabilities on the following behaviors; holding the book, indicating the tempo and turning the pages. It seems that children with ID were dominating the book reading sessions by showing these behaviors. This is probably caused by their lack of interest for books and reading, as was also seen in the analyses of the questionnaires (i.e., child's storybook reading interest). It could , however, also be the case that as parents have less clear expectations of their child's literacy abilities, they allow their child to set the pace of storybook reading more and thus to dominate the book reading session.

The third research question focused on relationships between child characteristics and HLE within the group of children with ID. It was found that the better the child's intelligence and receptive and productive language skills were, the more active the child was with literacy materials and the more story and word orientation activities the child showed during storybook reading sessions. Children's level of book orientation (e.g., what a child knows about books) was related to the amount of literacy materials in the home and the child's activities with these materials. We can thus conclude that, as for children without disabilities, the HLE also makes an important contribution to the language and early literacy development of children with ID.

*Limitations and suggestions for future research*

The results of the present study should be interpreted in light of some limitations. First, to measure the HLE of the children, parent questionnaires were used. Parents may be tended to give socially acceptable responses and thus withheld any negative beliefs they had about literacy. In future research, questionnaires should therefore be supported by observational data of the HLE of children. In this way the literacy practices in the home can be observed, which will give more information about the HLE of the children and the interactions that occur between parents and their children.

Furthermore, some parents of children with ID indicated that they did not read to their child and therefore did not fill in the questionnaire. It thus seems that there are parents of children with ID that did not return the questionnaire for this reason. This could explain the lower response rate of the parents of children with ID (64% in contrast to 85% and 76% for the control groups). It would also mean that only those parents that actually did some literacy activities with their children responded to the questionnaire, suggesting that the differences between the groups may be even larger.

Another limitation is the lack of longitudinal data about the children's language and literacy development. The direction of the relationships found between HLE factors and children's language and literacy skills cannot be determined without longitudinal data. This means that it is unknown which aspects of the HLE may predict later language and literacy development of the children. Future research should take this into account and include longitudinal data of children's language and literacy development. This can shed more light on which aspects of the HLE may predict later language and literacy skills of the children.

*Clinical implications*

Some important clinical implications can be derived from the present study. First of all, it is important that parents are informed about their child's abilities to become literate and which role parents play in this development, as the results showed that many parents of children with ID did not know what to expect for their child's literacy development. Furthermore, literacy development should also become a more important goal for parents, as it is most often just not seen as a priority for those children. Becoming literate, however, may especially serve those children that have a hard time communicating effectively with others (e.g., children with speech-language impairments). Communicating effectively is almost always seen as a top priority goal by parents of children with intellectual disabilities, where becoming literate is placed at a consistently lower level (Marvin & Mirenda, 1993; Trenholm & Mirenda, 2006).

An important way to stimulate children's literacy development is making use of interactive storybook reading. The quality of storybook reading interactions has been shown to affect language and early literacy development of children with ID (Hargrave & Sénéchal, 2000; Peeters, Verhoeven, De Moor, et al., 2009). Instead of just reading a book cover-to-cover to their child, parents should be taught to make use of a more interactive way of reading in which they make sure their child takes a more active role in the interaction. In a study of Katims (1994), children with ID were repeatedly read the same stories, which made them familiar with the text. This familiarity made it possible for the children to reenact the stories and relate the stories to their daily life. Furthermore, scaffolding during storybook reading leads to vocabulary development and an increase of communicative turns in children with language impairments (Crowe, Norris, & Hoffman, 2004; Hargrave & Sénéchal, 2000). Enhancing children's activity during storybook reading can also be done by introducing or using Augmentative and Alternative Communication (AAC) (e.g., objects, pictograms, and signs) during storybook reading, which will give non-verbal children the possibility to react on the story.

Literacy instruction in classrooms for children with ID should be concrete and meaningful (Katims, 2000). Many teaching activities, however, focus on teaching isolated subskills to children. Children with ID have difficulty with learning these abstract skills and with the transfer of this isolated knowledge to reading books for information and pleasure. However, research has demonstrated that when literacy teaching is done in a meaningful context in which the interest of the child is followed, children with ID are able to become literate in a conventional way (Koppenhaver & Erickson, 2003; Koppenhaver et al., 1991).

To conclude, there are differences between the HLE of children with ID and the HLE of children without disabilities. These differences are largest when children are compared with children of the same chronological age. When children of the same mental age are compared, differences in activities children engage in themselves still remain, indicating that the HLE is largely influenced by the cognitive disabilities of the children. However, parents also adapt their level to the developmental level of their child, which may not always be the most stimulating for the children.

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**Appendix.** Results of the Factor Analyses of the Four Parent Questionnaires

*1. Factor Analysis of Child's Literacy Interest*

| Items | Factor 1 | Factor 2 | Factor 3 |
|---|---|---|---|
| Child's literacy interest | Child's writing activities | Child's storybook reading interest | Child's activities with literacy materials |
| Frequency of using child magazines | -.04 | -.02 | **.59** |
| Frequency of using comic books | -.13 | -.08 | **.45** |
| Frequency of using dictionaries and/or encyclopedias | -.08 | .05 | **.37** |
| Frequency of using a computer or typewriter | .21 | -.09 | **.51** |
| Frequency of using play-do books | -.01 | .09 | **.45** |
| Frequency of using writing materials | **.99** | -.06 | -.13 |
| Frequency of using drawing materials | **.84** | -.00 | -.10 |
| Child's interest in drawing, painting or coloring | **.60** | .06 | .09 |
| Child's interest in writing or reading letters or words | **.40** | .15 | .29 |
| Frequency of using child books | .03 | **.63** | .03 |
| Child's interest in storybook reading | .00 | **.84** | .04 |
| Frequency of asking to be read to | -.02 | **.95** | -.09 |
| | | | |
| Reliability coefficient (Cronbach's $\alpha$) | .77 | .73 | .63 |
| Eigenvalue | 3.85 | 1.78 | 1.43 |
| Percent explained variance | 29.61 | 13.66 | 10.99 |
| | | Intercorrelations | |
| 1 | - | | |
| 2 | .42 | - | |
| 3 | .30 | .41 | - |

*2. Factor Analysis of Child's Activities during Storybook Reading*

| Items | Factor 1 | Factor 2 | Factor 3 | Factor 4 |
|---|---|---|---|---|
| Child's activities during storybook reading | Story orientation activities | Book orientation activities | Picture orientation activities | Word orientation activities |
| Holding the book | .10 | **.55** | -.05 | .08 |
| Indicating the tempo | -.06 | **.53** | -.12 | .05 |
| Turning the pages | -.02 | **.79** | .12 | -.09 |
| Pointing at pictures | -.08 | -.02 | **.98** | -.01 |
| Naming pictures | .21 | -.04 | **.40** | .16 |
| Pointing at letters or words | -.07 | .07 | .02 | **.87** |
| Reading aloud letters or words | .18 | -.07 | .03 | **.40** |
| Asking questions about the story | **.62** | -.16 | .08 | -.11 |
| Retelling the story in own words or by using AAC | **.60** | .13 | .03 | .02 |
| Guessing how the story will end | **.64** | .03 | -.07 | .04 |
| Give comments on the story | **.60** | -.03 | -.09 | .07 |
| Make up own story with the pictures | **.70** | .10 | .02 | -.09 |
| Relating the story to experiences in daily life | **.45** | -.06 | -.01 | .07 |
| Reliability coefficient (Cronbach's $\alpha$) | .71 | .73 | .68 | .61 |
| Eigenvalue | 3.40 | 1.85 | 1.30 | 1.06 |
| Percent explained variance | 26.17 | 14.20 | 10.01 | 8.17 |
| | | Intercorrelations | | |
| 1 | - | | | |
| 2 | -.01 | - | | |
| 3 | .27 | .16 | - | |
| 4 | .45 | .04 | .26 | - |

*3. Factor Analysis of Materials and Parental Activities for Child Literacy Development*

| Items | Factor 1 | Factor 2 | Factor 3 | Factor 4 |
|---|---|---|---|---|
| Materials and parental activities for child literacy development | Provision of literacy materials | Parent storybook reading interest | Parent literacy mediation | Parent play activities |
| Number of own book of the child | **.52** | .26 | -.02 | -.01 |
| Number of child magazines available | **.40** | -.13 | .09 | .04 |
| Number of child books | **.74** | .26 | -.23 | -.02 |
| Number of comic books | **.40** | -.06 | -.10 | .03 |
| Number of dictionaries or encyclopedias for children | **.57** | .03 | -.14 | -.02 |
| Number of tape-recorded stories | **.45** | -.20 | .19 | -.07 |
| Number of songbooks | **.44** | -.04 | .07 | .01 |
| Number of play-do books | **.55** | -.19 | .25 | .21 |
| Frequency of reading to the child | -.08 | **.88** | .12 | -.10 |
| Enjoying storybook reading to the child | -.07 | **.50** | .08 | .15 |
| Frequency of picture-book reading together with the child | .03 | **.74** | .04 | .05 |
| Frequency of involving the child in own reading | .03 | -.02 | **.41** | .13 |
| Frequency of involving the child in own writing | -.09 | .07 | **.62** | .11 |
| Frequency of playing rhyme games with the child | .20 | .05 | **.39** | -.10 |
| Frequency of reading names or letters with the child | .08 | .03 | **.65** | -.04 |
| Frequency of reading recipes or shopping lists with the child | -.11 | .03 | **.70** | .07 |
| Frequency of playing with the child | -.10 | .23 | -.03 | **.64** |
| Frequency of playing outside the home with the child | .06 | -.04 | .02 | **.55** |
| | | | | |
| Reliability coefficient (Cronbach's $\alpha$) | .75 | .75 | .71 | .23 |
| Eigenvalue | 4.44 | 2.18 | 1.86 | 1.28 |
| Percent explained variance | 20.20 | 9.89 | 8.46 | 5.82 |
| | | Intercorrelations | | |
| 1 | - | | | |
| 2 | .47 | - | | |
| 3 | .29 | .28 | - | |
| 4 | -.03 | .29 | .23 | - |

*4. Factor Analysis of Parents' own Literacy Materials and Activities*

| Items | Factor 1 | Factor 2 | Factor 3 | Factor 4 |
|---|---|---|---|---|
| Parents' own literacy materials and activities | Parent book reading | Parent email use | Parent magazine reading | Parent newspaper reading |
| Number of reading books | **.64** | .06 | .12 | .05 |
| Number of study books | **.80** | .01 | -.10 | .07 |
| Number of dictionaries and encyclopedias | **.65** | -.12 | .11 | .03 |
| Frequency of reading informative books | **.45** | -.01 | .05 | -.03 |
| Frequency of writing a letter or story | **.38** | .20 | -.16 | -.10 |
| Number of magazines | .19 | -.10 | **.63** | -.17 |
| Frequency of reading magazines | -.12 | .12 | **.75** | .11 |
| Number of newspapers | .10 | -.09 | -.04 | **.48** |
| Frequency of reading the newspaper | .02 | .06 | -.02 | **.77** |
| Frequency of reading email | -.02 | **.79** | -.01 | -.04 |
| Frequency of writing email | .04 | **.90** | .05 | .00 |
| | | | | |
| Reliability coefficient (Cronbach's $\alpha$) | .76 | .88 | .67 | .58 |
| Eigenvalue | 3.01 | 1.80 | 1.36 | 1.23 |
| Percent explained variance | 25.08 | 15.03 | 11.33 | 10.23 |
| | | Intercorrelations | | |
| 1 | - | | | |
| 2 | .15 | - | | |
| 3 | .34 | .19 | - | |
| 4 | .34 | .03 | .26 | - |

# Immersive Communication Intervention for Speaking and Non-speaking Children with Intellectual Disabilities*

*Chapter 5*

**Abstract**

The current study demonstrates the effectiveness of an intervention that addresses both home and day care for children with intellectual disabilities while also taking the large individual differences between the children into account. The KLIN*c* Studio intervention was designed to improve the language development, communication skills, and emergent literacy of 10 children with complex communication needs. The focus of the anchor-based intervention program was on the stimulation of vocabulary learning via the incorporation of AAC into the learning environment in the most natural manner possible. While all of the children showed significant progress across the intervention period of two years, the group of speaking children showed greater development in the domains of receptive language and productive syntax than the group of non-speaking children. For heterogeneous groups of children with disabilities, the use of a combined intervention such as that described here appears to be promising.

*This chapter was published as: Van der Schuit, M., Segers, E., Van Balkom, H., Stoep, J., & Verhoeven, L. (2010). Immersive communication intervention for speaking and non-speaking children with intellectual disabilities. *Augmentative and Alternative Communication, 26*, 203-220.

## Introduction

Children with intellectual disabilities (ID) often show delays in their language acquisition. Their language develops slower than that of typically developing children but appears to follow the same developmental path (Bates, Dale, & Thal, 1995). For most children with ID, their language abilities are at the level of their mental age (Chapman, 1997; Rondal, 2001); however, when the communicative environment offers sufficient and individualized support, they can master quite complex communication skills (Kaiser, Hester, & McDuffie, 2001). Nevertheless, as a group, children with ID vary greatly. General intellectual disabilities may be accompanied by problems with adaptive skills in the areas of speech, language, and social activities (American Association on Intellectual and Developmental Disabilities [AAIDD], 2009). In the present study, a combined dynamic assessment and intervention program designed to improve the language development, emergent literacy, and communication skills of both speaking and non-speaking children with ID was investigated.

*Language Acquisition of Children with Intellectual Disabilities*

Typically developing children appear to acquire language in a more or less continuous manner despite considerable individual variation in rate and style (Dale & Goodman, 2005; Friederici, 2005). The development of language comprehension always precedes language production by several months. This means that children already understand much of the speech that they hear before they start using language productively (Dale & Goodman, 2005). Productive vocabulary emerges slowly but, at around the 18-month mark, or when a productive vocabulary of 50-100 words is acquired, vocabulary growth accelerates rapidly in what is sometimes called a “vocabulary burst” (Fenson et al., 1994). At about 18 months, while children are continuing to add new words or lexical items to their vocabulary and gain sensorimotor control, gestures may be used in conjunction with single words; these gesture-word combinations generally signal the onset of two-word combinations (Bloom, 2000; Lock, 1978), the beginning of productive syntax. These combinations increasingly reflect early syntactic types that are most prevalent in the language input of parents and caregivers (Tomassello, 2003). The appearance of the first word combinations around the time of the vocabulary burst and early word-gesture combinations suggests a causal relation between vocabulary development and the onset of grammatical development. That is, children need to actively use a minimum of 50-100 words before their grammatical development can begin, which is referred to as the “critical mass hypothesis” (Bates & Goodman, 1997; Marchman & Bates, 1994). Research further suggests that early grammatical knowledge is organized around specific words, early gesture-word combinations and formulaic phrases or so-called templates from more general patterns are later abstracted and applied to new words and meanings (Akhtar, 1999; Lieven, Pine, & Baldwin, 1997; Tomasello, 2003). Children's vocabulary development is critical for not only their grammatical development but also their emergent literacy (Wagner, Muse & Tannenbaum, 2007): Vocabulary development is an important predictor of literacy development (Sénéchal, LeFevre, Smith-Chant, & Colton, 2001).

The pattern of language development for children with ID is less clear, particularly when the intellectual disabilities are accompanied by severe speech-language deficits, as is often the case in children with autism, Down syndrome, Fragile X syndrome or Velo-Cardio-Facial syndrome (VCFS) (Landa, 2007; Rondal, 2001; Sphrintzen, 2000). And, while the language development of children with ID resembles the language development of typically developing children at least to some extent, timing and outcomes are more varied, and individual differences are more pervasive and often do not reflect the child's developmental age (e.g., major articulation, vocabulary, and/or syntax delays (Kaiser et al., 2001). These individual differences can be largely attributed to syndrome differences (Rondal, 2001). For example, children with Down syndrome show specific weaknesses in the areas of speech production and intelligibility, and syntax (Roberts, Price, & Malkin, 2007). Difficulties may be due in part to their poor verbal short-term memory, which impairs the ability to detect and store phonetic efficiently (Hick, Botting, & Conti-Ramsden, 2005; Jarrold, Baddeley, & Phillips, 2002). Young children with autism show specific difficulties in following another person's gaze cues and with establishing and maintaining joint attention (Mundy, Sigman, & Kasari, 1990). Joint attention is thought to be an important predictor of language (i.e., vocabulary) development; shared attention is assumed to help the child understand that a particular word is being used to refer to the object of attention, thereby facilitating the learning of new words (Tomasello, 2003; Tomasello & Farrar, 1986). Children with autism also show related difficulties in later language learning that are primarily related to (a) the pragmatic aspects of communication (e.g., conversational turn-taking, topic maintenance, and figurative language) (Landa, 2007); and (b) difficulties with integration and coherence in processing of sensory information (Noens & Van Berckelaer-Onnes, 2004).

For some children with ID, additional cognitive, motor, and/or sensory deficits can greatly interfere with acquisition and use of spoken language; these children are considered non-speaking although they are often able to use Augmentative or Alternative Communication (AAC). Children who use AAC may have difficulties in the functional referential use of language and/or representing multimodal language within the language faculty in order to transform meaning or concepts into a variety of forms (Jackendoff, 1997; Sturm & Clendon, 2004). These problems may be due to internal factors (e.g., attentional difficulties; short term memory limitations; sensory, cognitive, socio-emotional, linguistic and/or motor disabilities) or external factors (e.g., limited social, physical, and/or material adjustments in the environment). Delayed responding and slow output from an AAC system, for example, may increase working memories demands for children who use AAC and their conversation partners (McNaughton & Lindsay, 1995). That is, considerable time is needed to prepare, produce, and control linguistic output using an AAC device while keeping the intended message in mind. Productive language skills of children who use AAC may be further hindered by their relatively small active vocabularies and limited control over acquisition of new vocabulary (Sturm & Clendon, 2004). Early output often consists of relatively simple, noun-based and concrete one- and two- word utterances (Light, Collier, & Parnes, 1985a). Nonetheless, the use of AAC and voice output communication aids (VOCA's) clearly enhances the functional and productive language (Millar, Light, & Schlosser, 2006), even though receptive language skills may remain impeded by limited feedback about word meanings and so may result in missed opportunities to learn new concepts and words. Not being able to produce words may limit the internalization of lexical and phonetic word form (Light, 1997). Furthermore, children who use AAC have limited exposure to models of how to use their own output system: Communication partners may have difficulty using the AAC system themselves and with adequately applying AAC strategies in ways that would create and enhance the child's opportunities for communication and for exploring and experiencing language and meaning in natural contexts. As a consequence, the models of AAC system use provided by communication partners are limited, as are their expansions of messages that the children do actually produce using AAC (Sturm & Clendon, 2004).

Given the variations in the language development of children with ID, language interventions should be tailored to the individual child's strengths and weaknesses (Gerber & Kraat, 1992; Rondal, 2001). Learning should occur in contexts that are meaningful for the child and include tasks that are close to the child's own experiences, interests, and level of proximal development. In such a manner, the intrinsic motivation of children to acquire and master new skills can be appealed to and stimulated; that is, the information presented should be both recognizable and of interest to the child (Sijtstra, Aarnoutse, & Verhoeven, 1999).

Language intervention with an emphasis on vocabulary development should also consider the communicative environment of the child. The interaction between children and the people in their environments (e.g., parents, caregivers, teachers) is of major importance to early language and literacy development (McCartney, 1984; Whitehurst & Lonigan, 1998). Moreover, parents and teachers must know how to direct and adapt their language and communication to the needs of children with complex communication needs. The communicative environments of children with ID can greatly differ from those of typically developing children (Cardoso-Martins, Mervis, & Mervis, 1985; Ruskin, Kasari, Mundy, & Sigman, 1994); although it should be more contingent and responsive to the child's lead, often it is more directive and adult-guided (Light, Collier, & Parnes, 1985a, 1985b; Mahoney & Wheeden, 1999). Parents often adapt their language and communication to the productive language level of the child, but this may result in less diverse and complex talk that does not necessarily provide the optimal environment in which to stimulate communication and language development (Kaiser et al., 2001). Expansion of children's utterances (more complex vocabulary, greater information, and/or more complete syntax) in concrete rich contexts can optimize language learning and communicative competence of children requiring intervention (Kaiser, Hancock, & Hester, 1998; Romski, Sevcik & Adamson, 1999).

The home literacy environment (HLE) plays an important role in the development of language and literacy (Whitehurst & Lonigan, 1998). The HLE of children with ID has been found to differ from the HLE of not only typically developing children of the same chronological age but also typically developing children of the same mental age (Van der Schuit, Peeters, Segers, Van Balkom, & Verhoeven, 2009). Children with disabilities have fewer literacy materials present in their homes and engage in fewer literacy activities with their parents than typically developing children. Moreover, when compared to children of the same mental age, the main differences are the activities that the children engage in themselves rather than parent-initiated activities. Parents appear to adapt their interactions to the developmental level of their child, which may not always be most appropriate way to stimulate a child with delayed development.

In sum, the large individual differences in language development of children with ID suggest that varied and individualized adaptation of communicative environments are needed to support and stimulate communication and language development. Early intervention for language, communication, and literacy skills in both home and day-care settings is needed, and should be tailored to the developmental strengths and weaknesses of the individual child (Gerber & Kraat, 1992).

*Interventions to Support Language Development*

Most interventions designed to improve the language and communication of children with ID target only a single aspect of a child's development in these areas, such as (a) comprehension of linguistic concepts (Kim & Lombardino, 1991; Quill, 1997), (b) communication skills (Johnston, Nelson, Evans, & Palazolo, 2003; Koegel, Camarata, Valdez-Menchaca, & Koegel, 1998; Romski, Sevcik & Adamson, 1999; Sevcik & Romski, 1997; Skotko, Koppenhaver, & Erickson, 2004; Tannock, Girolametto, & Siegel, 1992), (c) mastery of an AAC system (Charlop-Christy, Carpenter, Loc, LeBlanc, & Kellet, 2002; Iacono & Duncum, 1995; Romski & Sevcik, 1996; Romski, Sevcik & Fonseca, 2003), (d) grammatical development (Harris, Doyle, & Haaf, 1996; Warren, Gazdag, Bambara, & Jones, 1994), (e) speech intelligibility (Dodd, McCormack, & Woodyatt, 1994), (f) spontaneous speech (Charlop & Trasowech, 1991; Matson, Sevin, Fridley, & Love, 1990), or (g) literacy (Erickson & Koppenhaver, 1995).

Some of these interventions target a particular skill and involve direct instruction with the child but do not consider the communicative environment or adaptations of it. For example, Koegel et al. (1998) taught question-asking in a clinical setting to children who had autism and rarely initiated verbal interaction. The children generalized the question-asking strategy to other settings (e.g., the home). The intervention also resulted in increased vocabulary learning. In a similar vein, Charlop-Christy et al. (2002) found that three children with autism who learned to use the Picture Exchange Communication System (PECS) (Bondy & Frost, 1994) also showed significant gains in speech and social-communicative behavior and decreased their problem behavior.

In other interventions for children with ID, the focus has been on the communicative environment and teaching parents or day care staff to elicit more communication from children. For example, Tannock et al. (1992) instructed mothers to stimulate social interaction, communication, and language development of their preschool children with developmental delays. The mothers did, indeed, become more responsive and less directive, and utilized more language modeling strategies with their children. The changes were still present four months after completion of the intervention, when the number of vocal turns taken by the children had also increased.

Another intervention designed to improve children's language and communication but in an indirect manner is milieu teaching (For a thorough description, see Warren & Kaiser, 1988.). In this approach, intervention is grounded in such daily interaction routines as explaining and commenting on activities, planning the day and activities, and nursery rhymes or storybook reading. Communicative partners are taught to follow the child's lead, prompt specific skills, and model the target skills when needed (e.g., vocabulary, communicative functions). The milieu approach has been shown to be particularly effective for promoting early language development (e.g., prelinguistic communication, vocabulary) in children using only two-word utterances on average (Warren & Yoder, 2004).

An integrated approach to stimulate literacy development in children with disabilities involves direct instruction of the child and adaptations of the environment through teaching parents and professionals to use supports such as pictures, printed words, and computers in their interactions with the child (Erickson & Koppenhaver, 1995). The assumption is that skills in communication, language, and emergent literacy develop in an interdependent manner and that this development occurs in a communicative environment that encompasses both the home and day care setting. Children must build a complex system of relationships between concepts and words via their experiences with the world around them, and thus will benefit most from an integrated approach to promote learning that is meaningful (Morrison, 1999).

*The KLINc Studio*

The aim of the present study was to explore the effectiveness of a multifaceted and experiential intervention program designed to introduce and increase a broad range of early language, literacy, and communication skills among children with complex communication needs. The intervention is referred to as the 'KLIN*c* Studio', which is an acronym for "Kids Learning to take INitiatives in *communication*" (see Stoep, Van Balkom, Luiken, Snieders, & Van der Schuit, 2008). In a two-year early intervention program for preschool children with intellectual and multiple disabilities, a special play and learning environment was created to introduce multimodal language representations and AAC (e.g., manual and tactile sign systems, graphic symbols, AAC devices with digital and synthesized speech output, photographs, interactive white board technology for multimedia-based interactive storybook applications, and multimedia support for learning and use of new graphic symbols and manual signs).

The authentic learning approach employed in the KLIN*c* Studio draws heavily upon the Reggio Emilia approach (Vakil, Freeman, & Swim, 2003), a pedagogical framework based on principles of experiential and meaningful learning that was developed in the Italian community of Reggio Emilia (Edwards, Gandini, & Forman, 1998; Gardner, 2006; Rinaldi, 2006). The idea is that the child builds knowledge or a complex system of relationships between concepts and words via multiple and repeated experiences. The child's own initiatives are thus at the center of all learning activities, and children are encouraged to explore the world around them. This educational philosophy was adapted and extended for the KLIN*c* Studio to meet the needs of children with intellectual and multiple disabilities. Adaptations were primarily related to the limited capacity and/or propensity of children with ID to initiate. The Reggio Emilia approach was originally employed with typically developing children who initiate and engage in a variety of roles using several modalities - what is sometimes called the "hundred languages of children" (Edwards et al., 1998, p. 10). The aim of the KLIN*c* Studio was thus to create the least restrictive but most supportive and appropriate environment possible, where a child could choose and engage in activities in line with his or her zone of proximal development (Vygotsky, 1962/1986). The activities are organized around an experiential core theme, or *anchor*, in order to facilitate meaningful learning, as advocated by Romski, Sevcik, and Adamson (1997). In anchor-based instruction (Verhoeven & Aarnoutse, 2000), the core theme or shared starting event (i.e., the anchor) is associated with (or anchored in) the current development and interest of the child, in order to increase and broaden experiential knowledge and vocabulary associated with the anchor. Each cycle of activities begins with a group excursion or experience (i.e., event) organized around a central theme providing the anchor for the subsequent activities in the cycle and capturing the attention and interest of the children, motivating them to engage in activities and providing them with a shared set of experiences.

Over the 9-week period, several activities related to the anchor but that vary in complexity and the skill being targeted (e.g., vocabulary, phonemic awareness, story comprehension, AAC) are presented to help the children acquire new knowledge and a network of vocabulary associated with the anchor. The children have opportunities for experiential language learning, and to learn the new vocabulary; graphic-visual (e.g., pictures, symbols, drawings, photographs, multimedia) and motor-visual language representations in AAC (e.g., gestures, manual signs), and written language (e.g., wordlists, various representations of alphabetical characters). Stoep and Van Elsäcker (2005) describe how interactive anchored instruction can be used in preschool classrooms with children who have language delays and come from diverse cultural and socio-economic backgrounds. The use of anchored instruction for interactive literacy education is described by Bronkhorst, Paus, and Verhoeven (2008), Kinzer and Wilber (2008), and Sharp (2008).

At the KLIN*c* Studio, the children are regularly tested and observed using *dynamic assessment* protocols in order to closely monitor progress throughout the intervention and address individual needs. This information provides input for team meetings that are held about every nine weeks with the child's parents, teachers, and therapists. Progress is evaluated and new goals are set for the next nine-week cycle. Meaningful learning contexts are established for the child, and parents become actively involved in the intervention process. Parents are equipped with materials such as thematically related storybooks, multimedia reports of anchor events, and pictograms for words from the relevant semantic networks for use in the home environment; they receive information on the use of AAC (e.g., manual signing, graphic symbol use), interactive storybook reading and the use of AAC and AAC-devices, and practical hints for the stimulation of language in daily home situations in order to create an exciting learning environment.

AAC was incorporated into the KLIN*c* Studio environment in a very natural manner. The children are guided in their communication with adults and peers, and their use of various modes of communication is encouraged as a means of increasing communicative success. For non-speaking children, AAC play an important role in providing opportunities for meaningful interaction. In addition to manual signs (e.g., Sign Supported Dutch (SSD) and simplified manual sign registers), several easy to operate AAC devices and VOCAs can be used. In addition, individualized communication books are created using ClassroomSuite (from IntelliTools®)[1] in combination with interactive white boards. With these AAC methods, strategies, and devices, the children are thus able to interact with computers, and access software that is tailored to their individual language and cognitive levels and learning needs. For the KLIN*c* Studio, several templates that address the individual experiences and needs can also be designed, such as digital storybooks, matching exercises, interactive narrative puzzles, and interactive plates for telling and retelling stories.

*The Present Study*

In order to evaluate the effectiveness of the KLIN*c* Studio, the following research questions were posed.

1. To what extent does the intervention promote the development of vocabulary and production of multi-word utterances (i.e., syntactic development)?
2. To what extent are there differences in the development of receptive and productive language skills for speaking versus non-speaking children during the intervention period?

[1] IntelliTools®, Inc., Novato, California, www.intellitools.com.

With regard to the first question, the prediction was that the children would show strong growth in vocabulary during each of the nine-week anchor cycles. We also expected vocabulary development to transfer to their production of multi-word utterances.

With regard to the second question, we expected the language development of speaking children to be higher at the start of the intervention and to show a greater increase during the intervention period when compared to the language development of non-speaking children. As the use of AAC was incorporated into the intervention, non-speaking children were expected to have more opportunities for successful communication and learning opportunities specifically tailored to their needs. As a result, it was expected that their productive language would begin to develop, and that clear transitions from pre-linguistic to linguistic communication and single- to multi-word utterances would occur (Paul, 1997; Romski et al., 1997). In other words, it was expected that the non-speaking children would start to catch up with the speaking children during the course of the intervention.

## Method

*Participants*

The participants were 10 preschool children with multiple disabilities, 8 boys and 2 girls. Their chronological age (CA) at the start of the study was between 2 years and 6 years (mean CA = 4;2 years;months). All of the children had an intellectual disability (i.e., a nonverbal IQ between 50 and 70) and severe speech and language disabilities. Some children also had psychomotor disabilities (i.e., coordination problems, fine motor problems), sensory disabilities, an Autism Spectrum Disorder (ASD), and/or Attention Deficit Hyperactivity Disorder (ADHD). All of the children were able to walk without help. The intellectual disabilities for three of the children were clearly associated with a syndrome: two with Down syndrome and one with Velo-Cardio-Facial Syndrome; the etiology for the other children was unknown. The children's receptive language age was at least 18 months and they produced at least 10 words, manual signs or graphic symbols. The children's primary language was Dutch. All parents were cooperative and willing to carry out the intervention at home. Parents and caregivers provided their informed consent prior to participation. An overview of the child characteristics can be found in Table 1.

The 10 children were divided into two groups: five who mainly used speech and five who used AAC systems to communicate, including manual sign systems such as Sign Supported Dutch, a combination of speech and manual signs; graphic symbols; and VOCAs. At the start of the intervention, the two groups did not differ significantly with regard to chronological age, $F(1, 9) = 3.18$, $p = .112$; developmental age, $F(1, 9) = 0.002$, $p = .966$; or receptive language age ($F(1, 9) = 0.40$, $p = .546$), but, the speaking group showed higher productive language skills than the non-speaking group (productive syntax age, $F(1, 9) = 5.56$, $p < .05$; productive vocabulary age, $F(1, 9) = 7.05$, $p < .05$). The groups did not differ in terms of physical disabilities. The two children with Down syndrome and the two children with ASD were in the non-speaking group; they could produce a few words for familiar objects or people (e.g., mama, papa), but most of their speech was unintelligible. Some of the children had been using graphic symbols, photographs, and manual signs at the start of the intervention; nevertheless, the most appropriate AAC system was introduced as part of the intervention. In this way, it was possible to determine which communication system was most appropriate for each child. During the planning and evaluation meetings, the use of the AAC was discussed, and any needed changes or adjustments were made together with the children's parents, caregivers, and therapists. Training in Sign Supported Dutch and the use of the AAC systems was also provided next to these meetings.

Table 1. *Child Characteristics at the Start and End of the Two-year Intervention Period*

| | | | | *Start of intervention* | | | | | *End of intervention* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Child* | *Sex* | *Etiology* | *Mode of communication* | *CA* | *MA* | *RLA* | *PSA* | *PVA* | *CA* | *MA* | *RLA* | *PSA* | *PVA* |
| 1 | M | Psychomotor disability | Speech | 2;9 | 1;11 | 1;7 | 1;5 | 1;6 | 4;4 | 4;5 | 3;8 | 3;9 | 3;5 |
| 2 | M | Psychomotor disability | Speech | 3;4 | 1;6 | 1;9 | 1;6 | 1;6 | 5;4 | 3;6 | 2;8 | 2;6 | 2;6 |
| 3 | M | VCF syndrome | Speech | 4;2 | 2;9 | 2;9 | 2;10 | 2;10 | 6;2 | 3;11 | 4;3 | 4;2 | 3;11 |
| 4 | M | Cognitive disability | Speech | 3;4 | 2;4 | 2;1 | 1;8 | 2;7 | 5;5 | 4;2 | 4;8 | 3;0 | 4;5 |
| 5 | M | Cognitive disability, ADHD | Speech | 4;5 | 2;9 | 2;8 | 2;5 | 3;10 | 6;5 | 4;2 | 4;11 | 5;9 | 5;9 |
| 6 | M | Cognitive disability, ASD | GS | 2;11 | 2;0 | 1;1 | <1;0 | <1;0 | 4;9 | 3;4 | 2;0 | 2;2 | 2;2 |
| 7 | M | ASD, motor disorder (dyspraxia) | GS, MS | 4;0 | 1;7 | 2;6 | 1;0 | 1;0 | 6;0 | 3;7 | 3;7 | 2;2 | 3;5 |
| 8 | F | Down syndrome, ADHD | GS, MS | 5;0 | 2;0 | 2;4 | 1;5 | 1;5 | 7;0 | 3;6 | 3;2 | 1;9 | 3;5 |
| 9 | F | Down syndrome, auditory disability | GS, MS | 5;3 | 3;4 | 2;4 | 1;9 | 1;9 | 7;5 | 4;3 | 2;11 | 1;9 | 2;9 |
| 10 | M | Psychomotor disability | GS, MS | 6;8 | 2;3 | 1;5 | <1;0 | <1;0 | 8;8 | 2;11 | 2;6 | 1;9 | 2;6 |

*Note:* M= Male; F=Female; ASD= Autism Spectrum Disorder; ADHD=Attention Deficit Hyperactivity Disorder; CA=Chronological Age; MA=Mental Age; RLA=Receptive Language Age; PSA=Productive Syntax Age; PVA=Productive Vocabulary Age; GS=Graphic Symbols; MS=Manual Signs.

*Intervention*

The intervention was conducted across a period of two years. The children attended the KLIN*c* Studio five days a week - one group in the morning and one group in the afternoon - for a total of 2.5-3 hours per day. The groups were formed on the basis of the children's chronological and developmental age, and both groups included speaking and non-speaking children. The same two teachers were involved in the entire intervention, and were assisted during some of the activities by teaching assistants, speech-language therapists, a physical therapist, a music therapist, and/or a remedial teacher.

An overview of the activities used during a nine-week anchored cycle is presented in Appendix A. Teachers and parents prepared each cycle during core-team meetings. Based upon the group goals identified for each cycle, individual goals were established for each child as concrete activities to be carried out at home and at the day care facility. A vocabulary network associated with the core theme for a nine-week anchored cycle is presented in Appendix B. The words in the vocabulary network are selected and arranged on the basis of the "thousand-and-one" list of first words for typically developing toddlers in Dutch (Bacchini, Boland, Hulsbeek, Po, & Smits, 2005). The words in the top row are the simplest; those in the second and third rows are more advanced but also deemed relevant for inclusion in the learning environment. The words in the bottom row do not come from the list of first words but are relevant for the theme and/or opening event.

A key factor in the efficacy of anchored instruction is the use of manual signs (SSD), graphic symbols, photographs, and films made during the opening event for each cycle. This audiovisual information allows the children to relive their shared familiar experiences, which facilitates communication about the event and central theme during activities in the cycle. The development of the children during each of the anchored cycles was closely followed using dynamic assessment (Van der Schuit, Van Balkom, Segers, & Verhoeven, 2008). In this way, the activities at the KLIN*c* Studio could be tailored to the developmental strengths of each child and adjusted to accommodate disabilities.

At the start of each anchored cycle, the parents were asked to indicate which concepts and words their child already knew receptively and which words the child used productively. The children's receptive and productive knowledge of the anchor words was also pre- and post-tested. In addition, the interactions of the children with each other and/or their caregivers in the KLIN*c* Studio were videotaped at lunchtime during the second, third, and fourth weeks of the anchor period. These videos were time-coded, observed, and analyzed for the use of communicative functions and modes of communication. The assessment results were then used to evaluate the child's progress and set new intervention goals for the next anchored cycle during the core-team meeting that took place during the last week of an anchored cycle.

In addition to vocabulary assessment and videotaped observation, development was also assessed on a more long-term basis using standardized tests of nonverbal intelligence, receptive and productive language skills. These were administered at the start of the intervention and then again 12, 18, and 24 months later in order to monitor the results and to adjust the interventions for the individual children.

*Procedure and Materials*

The children were tested during their time at the KLIN*c* Studio. Each child was assessed individually in a quiet room by a trained examiner (a speech-language therapist or developmental psychologist). Test sessions lasted 30-40 minutes, depending on the child's concentration and abilities. For most of the children, productive and receptive vocabulary could be tested in a single session. Instructions were given verbally and supported with sign language when necessary. About three sessions per child were necessary for administration of the standardized tests. For most children, sessions were conducted on different days within a period of no more than three weeks.

*Curriculum-based assessments.* The pre- and post-cycle vocabulary tests contained 50 words taken from that cycle's word network. Receptive vocabulary was always tested prior to productive vocabulary, by showing four pictures and asking the child to select the picture depicting the target word. The four pictures depicted the target anchor word (*cheese* [kaas]), a semantically related word (*bread* [brood]), a sound-related word (*candle* [kaars]), and an unrelated word (*swing* [schommel]). In the productive vocabulary test, the child was asked to name a picture of the anchor word. Some children required prompts (e.g., What is the boy doing?). The child could respond using speech or manual signs, or by pointing to a photograph or graphic symbol that was different from the picture used in the test.

*Standardized tests.* Nonverbal intelligence was assessed using the Revised Snijders-Oomen Nonverbal Intelligence Test (SON-R 2 ½ - 7) (Tellegen, Winkel, Wijnberg-Williams, & Laros, 2005), which does not use spoken or written language (Cronbach's alpha = .90). The test involves a reasoning scale (i.e., Situations, Categories, and Analogies) and a performance scale (i.e., Patterns, Mosaics, and Puzzles).

The instructions were given verbally, nonverbally using gestures, or by a combination of the two. The child received feedback after each item, and, if necessary, the examiner demonstrated the correct solution. The examiner could also help the child a little with the completion of an item. In this way, a natural interaction between child and examiner took place and, if the child did not fully understand the task, the feedback provided by the examiner helped the child to understand.

Receptive language was assessed using the Dutch version of the Reynell Test for Language Comprehension (Van Eldik, Schlichting, Lutje Spelberg, Van der Meulen, & Van der Meulen, 2004), which is designed to measure comprehension of vocabulary and of grammatical structures by children between 1;2 and 6;3 (Cronbach's alpha = .90).

Productive language was assessed using the Schlichting Test for Language Production (Schlichting, Van Eldik, Lutje Spelberg, Van der Meulen, & Van der Meulen, 2003), which includes two subtests: sentence development or productive syntax (Cronbach's alpha = .85), and word development or productive vocabulary (Cronbach's alpha = .87).

For both the Reynell Test for Receptive Language and the Schlichting Test for Productive Language, the instructions were provided verbally but supported with sign language as necessary for a particular child. Those children using Sign Supported Dutch or sign language for production were encouraged to do so during their testing and all answers provided using manual signs were judged to be acceptable. The Schlichting Test for Productive Language always administered after the Reynell Test for Receptive Language.

*Statistical Analyses*

The statistical analyses were conducted using SPSS 14.0. First, the children's relative progress after controlling for their initial levels of performance on the curriculum-based vocabulary tests, was computed for the group as a whole and tested using one sample *t*-tests. Second, age equivalents for the child's total scores on the tests of nonverbal intelligence, receptive and productive language skills were determined using the norms from the relevant test manuals; the descriptive statistics for the children in our study were then computed and analyzed using repeated measures Analyses of Variance (ANOVAs).

A Proportional Change Index (PCI) [2] was also computed for each child (cf., Wolery, 1983) by comparing the child's rate of development prior to the intervention to the child's rate of development during the intervention. Rate of development prior to the intervention was computed by dividing the child's developmental age by chronological age at the start of the intervention. The child's rate of development *during* the intervention was calculated by dividing the developmental gain during the intervention by the duration of the intervention. If the child showed similar progress during the intervention as before the intervention, the value

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[2] $$\text{PCI} = \left(\frac{\text{developmental gain}}{\text{time in intervention}}\right) \Big/ \left(\frac{\text{pretest developmental age}}{\text{pretest chronological age}}\right)$$

of the index is one. If the child showed greater or lesser progress during the intervention rather than before the intervention, the value of the index will be above or below one. To determine if the index differed significantly from one, a one sample *t*-test was conducted.

ANOVAs were conducted using the descriptive statistics for the two groups of children (speaking and non-speaking) to determine if their performance on the different tests differed. In addition, General Linear Model (GLM) Repeated Measures analyses using a multivariate approach (Van den Bercken & Voeten, 2002) were conducted to determine if the children's development across the two groups differed significantly during the course of the intervention; the outcomes for one of the standardized tests constituted the dependent variable in the GLM Repeated Measures analyses with Time (measurement points 1, 2, 3 and 4) as a within-subject independent variable and Group (speaking or non-speaking) as a between-subjects independent variable.

## Results

To answer the first research question, which concerned the stimulation of the children's vocabulary and syntactic development by the intervention, the relative progress of the children on the curriculum-based tests during each anchored cycle was examined. One sample *t*-tests revealed highly significant progress and large effect sizes (all $d$s > 1.53) for all of the curriculum-based tests across all of the anchored cycles (see Table 2). All of the children made significant gains in their receptive and productive language during the nine-week anchored cycles.

Table 2. *Results of t-tests for Children's Relative Progress on Anchor-based Vocabulary Tests (Receptive and Productive)*

| | Receptive | | | | Productive | | | |
|---|---|---|---|---|---|---|---|---|
| Anchor | *df* | *t* | *p* | *d* | *df* | *t* | *p* | *d* |
| People | 9 | 4.54 | .001*** | 3.03 | 9 | 4.15 | .002** | 2.77 |
| Shop | 9 | 4.87 | .001*** | 3.25 | 9 | 3.36 | .008** | 2.24 |
| Circus | 9 | 2.29 | .048* | 1.53 | 9 | 2.47 | .035* | 1.65 |
| Traffic | 9 | 3.73 | .005** | 2.49 | 9 | 2.59 | .029* | 1.73 |
| Fairy Tales | 9 | 3.96 | .003** | 2.64 | 9 | 4.41 | .002** | 2.94 |
| House | 8 | 4.79 | .001*** | 3.39 | 8 | 4.45 | .002** | 3.15 |

* $p < .05$ (2-tailed): ** $p < .01$ (2-tailed): *** $p < .001$ (2-tailed)

The results of the repeated measures ANOVAs revealed a main effect of Time for all of the tests: nonverbal intelligence, Wilks' Lambda = .078, $F(3, 7) = 27.53$, $p < .001$, $\eta_p^2 = .92$; receptive language, Wilks' Lambda = .156, $F(3, 7) = 12.59$, $p < .01$, $\eta_p^2 = .84$; productive syntax, Wilks' Lambda = .110, $F(3, 7) = 18.93$, $p < .01$, $\eta_p^2 = .89$; and productive vocabulary, Wilks' Lambda = .047, $F(3, 7) = 47.46$, $p < .001$, $\eta_p^2 = .95$. In other words, the children showed significant progress across the two-year intervention period on all standardized tests.

When the PCI was computed to compare the children's development prior to and during the intervention, the results of the one sample *t*-tests showed the index to be significantly different from one for receptive language (PCI = 1.51, $t(9) = 2.48$, $p < .05$, $d = 1.65$)[3]. The children thus made significantly greater receptive language progress during the intervention compared to before intervention. For nonverbal intelligence and productive syntax, there was a trend towards greater progress during intervention than before intervention (nonverbal intelligence: PCI = 1.35, $t(9) = 2.05$, $p = .071$, $d = 1.37$; productive syntax: PCI = 1.72, $t(9) = 2.01$, $p = .075$, $d = 1.34$). For productive vocabulary, the index again differed significantly from one (PCI = 2.51, $t(9) = 2.36$, $p < .05$, $d = 1.57$); the children thus made more progress in productive vocabulary during the intervention than before the intervention.

The second research question concerned a comparison of the speaking versus non-speaking children and their development during the intervention period. Table 3 presents the mean developmental ages for the two groups on the standardized tests of nonverbal intelligence, receptive and productive language skills on the four measurement occasions during the two-year intervention period.

Figures 1, 2, and 3 display the children's receptive language, productive syntax, and productive vocabulary, respectively.

[3] Cohen's *d* was calculated using the formula, $d = 2t/\sqrt{df}$ (cf., Dunst, Hamby & Trivette, 2002).

Table 3. *Mean Developmental Age (in months) and Standard Deviations for Speaking and Non-speaking Children on Tasks across Measurement Occasions*

| | Time 1 (0m) | | Time 2 (12m) | | Time 3 (18m) | | Time 4 (24m) | |
|---|---|---|---|---|---|---|---|---|
| Task | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Nonverbal cognition | | | | | | | | |
| S | 27.0 | 6.52 | 36.6 | 9.18 | 43.4 | 10.85 | 48.4 | 4.16 |
| NS | 26.8 | 7.92 | 33.8 | 8.47 | 39.4 | 10.09 | 42.2 | 5.81 |
| Receptive language | | | | | | | | |
| S | 26.0 | 6.33 | 39.6 | 5.81 | 41.8 | 8.23 | 48.4 | 10.78 |
| NS | 23.2 | 7.66 | 27.4 | 9.69 | 26.4 | 9.69 | 34.0 | 7.31 |
| Productive syntax | | | | | | | | |
| S | 23.6 | 7.50 | 33.6 | 8.79 | 43.6 | 12.28 | 46.0 | 15.02 |
| NS | 14.4 | 4.45 | 20.8 | 1.30 | 23.0 | 3.00 | 23.4 | 2.51 |
| Productive vocabulary | | | | | | | | |
| S | 29.4 | 11.82 | 39.4 | 6.43 | 47.2 | 8.17 | 48.0 | 14.49 |
| NS | 14.4 | 4.45 | 22.0 | 7.62 | 29.2 | 5.26 | 34.2 | 6.69 |

*Note:* S=Speaking; NS=Non-speaking; *M* = Mean; *SD* = Standard Deviation

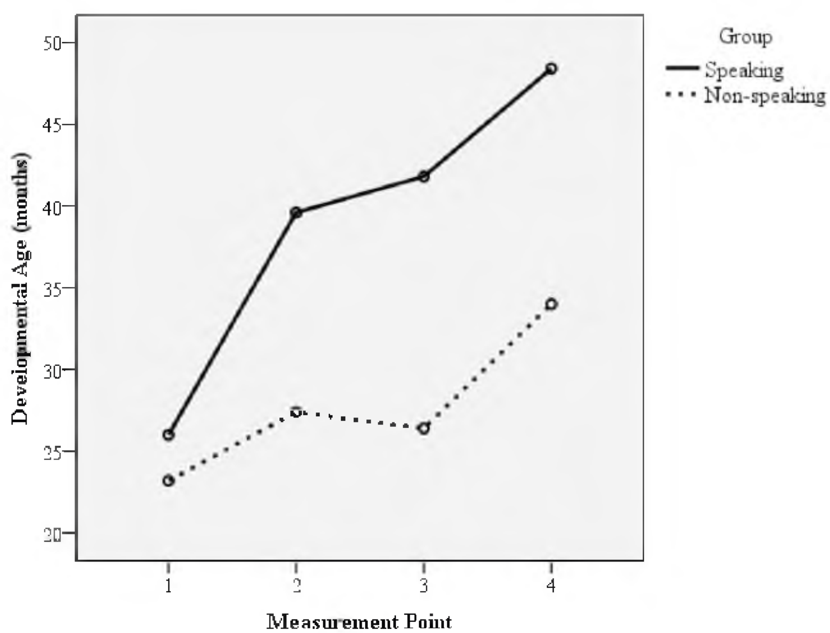


*Figure 1.* Receptive language age for the speaking and non-speaking children on each measurement occasion.

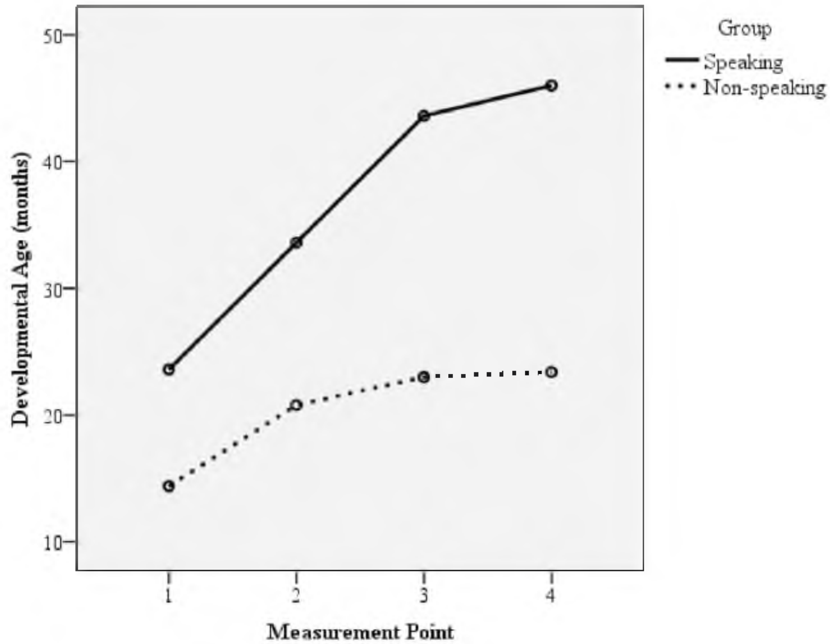


*Figure 2.* Productive syntax age for the speaking and non-speaking children on each measurement occasion.

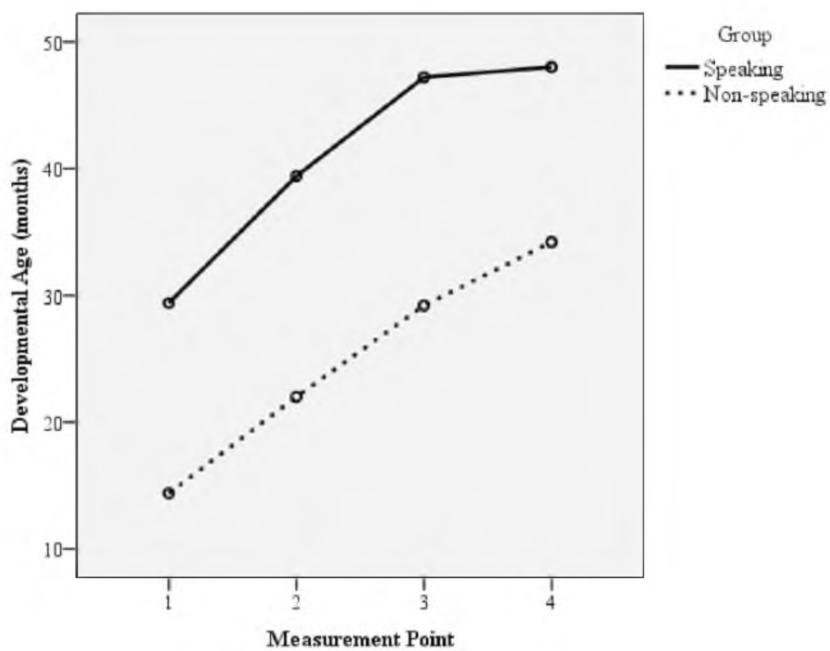


*Figure 3.* Productive vocabulary age for the speaking and non-speaking children on each measurement occasion.

The results of the repeated measures GLM show a marginally significant Time × Group interaction for both receptive language, Wilks' Lambda = .308, $F(3, 6) = 4.49$, $p = .056$, $\eta_p^2 = .69$, and productive syntax, Wilks' Lambda = .300, $F(3, 6) = 4.67$, $p = .052$, $\eta_p^2 = .70$. No Time × Group interaction was detected for either productive vocabulary, Wilks' Lambda = .843, $F(3, 6) = 0.37$, $p = .776$, $\eta_p^2 = .16$, or non-verbal intelligence, Wilks' Lambda = .732, $F(3, 6) = 0.73$, $p = .570$, $\eta_p^2 = .27$. There were differences between the speaking and non-speaking children in development of receptive language and productive syntax but not in development of nonverbal intelligence or productive vocabulary.

Although the children in both groups developed significantly during the two-year intervention period, those in the non-speaking group lagged behind those in the speaking group in a number of domains. The groups did not differ at the start of the intervention with respect to receptive language age but did differ on the three later measurement occasions (Time 2: $F(1, 9) = 5.83$, $p < .05$; Time 3: $F(1, 9) = 7.34$, $p < .05$; Time 4: $F(1, 9) = 6.10$, $p < .05$). The two groups also differed consistently with respect to productive syntax age on all of the later measurement occasions (Time 2: $F(1, 9) = 10.37$, $p < .05$; Time 3: $F(1, 9) = 13.28$, $p < .01$; Time 4: $F(1, 9) = 11.01$, $p < .05$). The two groups differed significantly in productive vocabulary age at measurement points two and three but not thereafter (Time 2: $F(1, 9) = 15.25$, $p < .01$; Time 3: $F(1, 9) = 17.16$, $p < .01$; Time 4: $F(1, 9) = 3.73$, $p = .089$). Thus, the productive vocabularies of the children in the non-speaking group appeared to catch up to those of the children in the speaking group by the end of the intervention period. Finally, the two groups did not differ significantly in nonverbal intelligence at any measurement time ($p$ = ns).

## Conclusions and Discussion

The purpose of the present study was to assess the effectiveness of an early language and communication intervention program that took into account the large individual differences between children with ID and included both the home and day care settings. The intervention provided in the KLIN*c* Studio was effective in promoting vocabulary learning. The KLIN*c* Studio was designed to provide children with severe speech and language disorders combined with intellectual and additional disabilities (e.g., ADHD, ASD) with a more contingent, responsive, and experiential language learning environment tailored to the individual child's strengths and weaknesses in order to make learning more meaningful (Stoep et al., 2008). During each of the nine-week anchored cycles (6 in total), all of the children showed significant progress in receptive and productive vocabulary (i.e., large effect sizes with all of the *d*s on the curriculum-based tests > 1.53). The children also showed significant gains in receptive and productive language during the two-year intervention period, as indicated by the standardized tests. Development during the intervention was found to be considerably greater than before the intervention (i.e., at baseline). The intervention led to vocabulary growth and syntactic development (e.g., greater use of multi-word utterances), with very large effect sizes ($d > 1.10$). These findings are in keeping with the findings of earlier studies showing early intervention aimed at the child, parents, caregivers, or teachers can be effective in improving the language and literacy development of children with ID (Charlop-Christy et al., 2002; Erickson & Koppenhaver, 1995; Tannock et al., 1992). Unique to the present study, however, is the use of not only an intervention aimed at the child, parents, *and* caregivers but also assessment within the domains of language, communication, *and* literacy. This immersion approach produced substantial developmental growth, and thus appears to be very effective for use with children who have intellectual disabilities accompanied by severe speech and language impairments.

Clear differences between the speaking and non-speaking children's development were also observed. During the intervention period, the speaking children showed greater progress in production of multi-word utterances than did the non-speaking children. It is possible that the non-speaking children may not have acquired a sufficient productive vocabulary "mass" to be able to start grammatical development. As the "critical mass hypothesis" suggests, a minimum of productive vocabulary is required to "kick start" children's grammatical development (Marchman & Bates, 1994). By Time 3, the non-speaking children had attained the same mean productive vocabulary age as the speaking children had at Time 1 (non-speaking children 29.2 months at Time 3; speaking children 29.4 months at Time 1). For the speaking children, a major change in the mean productive syntax age also appeared between Time 1 and Time 2 (age of 23.6 months at Time 1 vs. 33.6 months at Time 2). The speaking children had thus collected a sufficient "critical mass" of vocabulary items to kick start their grammatical development between Time 1 and Time 2. For the non-speaking children, their mean productive syntax age at Time 3 compared to Time 4 suggests that they had not yet acquired this minimum vocabulary level (age of 23.0 months at Time 3 vs. 23.4 months at Time 4). This means that, although the productive vocabulary of the non-speaking children appeared to catch up to that of the speaking children by Time 4, grammatical development continued to be delayed. A longer intervention period, then, may be required to initiate combining of concepts, words, signs, and symbols (i.e., grammatical development) for these children.

One explanation for the extended delay in the non-speaking children's productive syntactic development could be that the items in their developing receptive and productive vocabularies were not sufficiently embedded in a semantic network; that is, they may have been acquiring concepts and words largely in isolation despite efforts to embed them in a rich semantic network via anchor-based instruction. As learners of a language acquire words and gain greater experiential knowledge of the world, they typically form networks of concepts and semantic, syntactic, and phonological relationships, or what is often referred to as a *mental lexicon* (Aitchison, 1994). Children with ID may have mental lexicons that are less elaborate than those of typically developing children (Leonard & Deevy, 2004), in which weak links between the various components may hinder further vocabulary development, and phonological and grammatical development. For example, when children fail to understand that a word like *sit* is a verb and thus needs a subject like *I*, they may produce grammatically incorrect sentences because the specific information for a particular word is not stored or is incorrectly stored, leading to problems with grammatical, phonological, and semantic development. Thus, the non-speaking children in the present study may not have been able to benefit from the semantic networks incorporated into the activity-based intervention program. Their semantic memory skills (i.e., generalized knowledge that does not involve memory of a specific event) may not have interacted adequately with their episodic memory (i.e., autobiographical memory of specific events) although this was the intended purpose of the starting event and subsequent activities related to this event. (See Rajah & McIntosh, 2005, for a description of the different functions of episodic and semantic memory.)

The speaking children showed greater receptive language development during the two-year intervention period than the non-speaking children. Fernald, Perfors, and Marchman (2006) claimed that productive vocabulary development could lead to more efficient receptive language processing because experiences with spoken language can strengthen lexical representations. In addition, the child's production of a word may elicit feedback about the hypothesized meaning of a word (Light, 1997). The speaking children in the present study may develop and use their language more actively and obtain greater experience with the spoken language, thereby enhance their receptive understanding of language. The lexical restructuring model of Metsala and Walley (1998) provides an alternative explanation for the observed association between children's productive vocabulary development and enhanced spoken language recognition: As a child's vocabulary expands, he or she needs greater phonological awareness to identify the *correct* word in the mental lexicon. That is, the more words the child knows, the greater the number of possible answers in the mental lexicon and thus the need for increased phonological awareness to quickly access, retrieve and review alternative candidates in the search for the intended word or lexical item.

The differences between the speaking and non-speaking groups of children suggest a so-called Matthew effect (Stanovich, 1986): the rich get richer and the poor get poorer. The developmental ages on receptive and productive language tasks were higher for the speaking children than for the non-speaking children at the start of the intervention, and the developmental rate was also higher both before the intervention and during the intervention. Having already taken the first steps of language acquisition prior to the intervention, the speaking children may have been in a better position to benefit from the intervention. The speaking children may have also elicited more positive responses from the environment: because they were more communicative and understandable they would have had increased — and possibly more diverse — language experiences. As a result, the speaking children may have learned to utilize new learning experiences more efficiently (Walberg, Strykowski, Rovai, & Hung, 1984).

The anchor-based intervention used in this study appeared to be better suited to the needs and abilities of speaking children than non-speaking children; the latter group did not benefit from the use of AAC as much as we had expected. The observed differences in the developmental progress of the two groups can thus be explained in terms of individual differences between the groups of children and an environment that was better suited to the speaking than the non-speaking children.

*Limitations*

Limitations on the present study should be kept in mind in the interpretation of the results. First, the number of participants was small ($N$ = 10), so that the statistical analyses should be interpreted with caution. However, all of the children showed progress during the period of intervention and the effect sizes were large. Most studies of with children with complex communication needs involve a small sample size ($N$ < 10), especially those involving intensive intervention such as in the present study (e.g., Kim & Lombardino, 1991; Koegel et al., 1998; Warren et al., 1993). Future research should, therefore, include larger numbers of children so as to shed even greater light on the differences in learning gains for different groups of children. In addition to the need to include larger numbers of children in future studies, the intervention used in the current study should be explored in other settings, such as special education schools, to determine if it is suited for use in these learning environments. The data presented here were collected parallel to the development of the intervention itself. The present study can thus be viewed as formative; further data using the same or a very similar intervention should be collected in the future.

*Clinical Implications*

A number of clinical implications can be derived from the results of the present study. All of the children clearly increased their productive vocabularies during the course of the intervention. In contrast to the group of speaking children, the non-speaking group did not make the transition to the use of multi-sign or multi-symbol sequences. At the end of the intervention, the non-speaking children reached the same level of productive syntax as the speaking children were at the beginning of the intervention. Non-speaking children may require additional practice with newly acquired lexical items (symbols, manual signs) in order to reach a level that allows them to experiment with multi-sign sequences or multi-symbol sequences. The embedded use of AAC in an approach such as the KLIN*c* Studio may facilitate extension and enrichment of the mental lexicon (i.e., increasing semantic networks). The results of the present study showed that, when the intervention elicits multiple meaningful experiences and is sensitive (with the use of AAC) to the developmental level of the individual child, large and comprehensive effects can be achieved.

To achieve greater learning gains, then, future interventions should incorporate greater variety and intensity of use of AAC during daily life situations (e.g., more frequently for interactive storybook reading in the home, social play, and daily life activities). Furthermore, the learning environment should be arranged so that AAC can be used not only with children who require it for output but also as an input channel to provide a model for lexical concept formation and language comprehension. When using AAC, greater attention should be paid to prompting lexical and functional grammatical development by adapting the language input (with AAC). Parents, caregivers, and teachers should be coached to provide more adequate models of (adapted) language use for children (Light, 1997; Paul, 1997).

An immersive communicative environment such as the KLIN*c* Studio was found to promote lexical and language development of preschool children with ID and complex communication needs. The intervention proved particularly effective for the stimulation of receptive and productive vocabulary development, and revealed that vocabulary and grammatical development may be accelerated by an early intervention aimed at the stimulation of communication, language, and emergent literacy.

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## Appendices

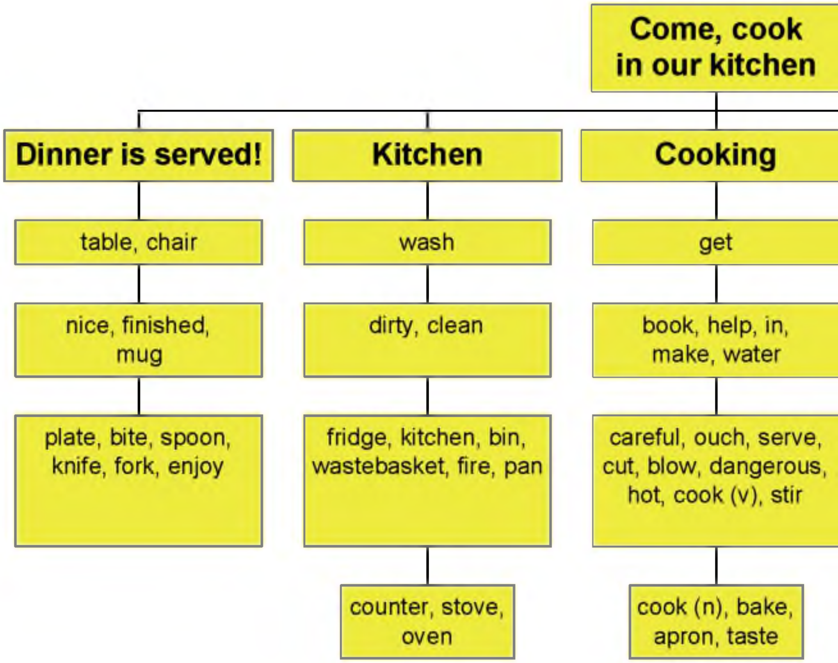
**Appendix A.** Activities to be undertaken during a nine-week anchored cycle

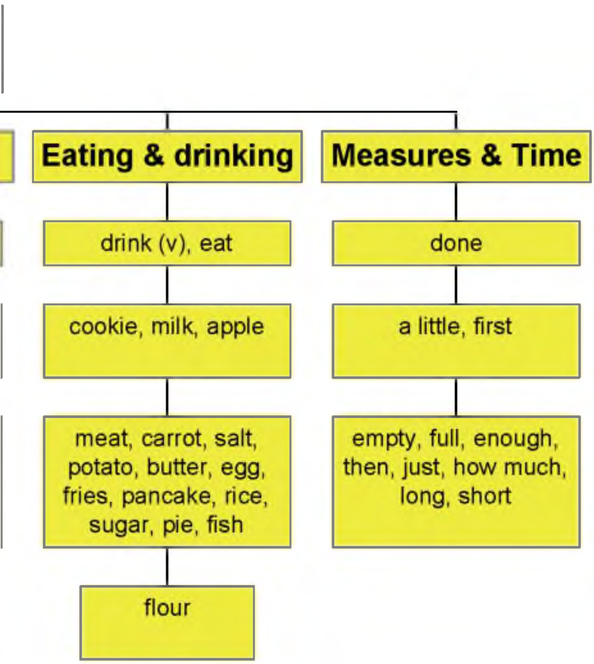
| Week | Current cycle | Cycle in preparation |
|---|---|---|
| 1 | ▪ Provide anchor-related materials for the day care facility<br>▪ Hold and record opening event, include brief clips of each child, and edit to a 12- to 15-min video of the whole event<br>▪ Develop child-specific activities and interactive storybook of event that includes personalized video clips of each child<br>▪ Assess start performance of each child (i.e., curriculum based vocabulary assessments)<br>▪ Prepare anchor-based (thematic) activities for each child | Evaluate previous anchor |
| 2 | ▪ Record activity-based intervention for each child, specifying approach and materials<br>▪ Specify individualized intervention goals and associated support, based on CCP<br>▪ Continue goal attainment- and support-related activities | |
| 3 | ▪ Continue goal/support activities | ▪ Determine theme, and construct vocabulary network for next anchor<br>▪ Select main story and accompanying storybook<br>▪ Plan topic and storylines for the new KLIN*c* storybook, *Melle & Grukke* |
| 4 | ▪ Test and observe to measure and evaluate progress towards goals | ▪ Plan opening event for next anchor. Select materials, picture books, and |

| | | |
|---|---|---|
| | ▪ Continue goal/support activities | storylines<br>▪ Draw pictures for the new KLIN*c* storybook, *Melle & Grukke* |
| 5 | ▪ Analyze results from tests, observations, and task performances, make interim report based on results<br>▪ Continue goal/support activities | ▪ Mail vocabulary checklist to parents to prepare next anchor period<br>▪ Prepare sign-language version of vocabulary sets for next anchor |
| 6 | ▪ Meet with staff and parents to share and discuss interim results<br>▪ Continue or modify goal/support activities, depending on results | ▪ Identify and purchase materials for anchor-related activities.<br>▪ Prepare recording sessions for sign language and interactive storytelling instructional DVD for next anchor (based on *Melle & Grukke* KLIN*c* storybook and main storybook) |
| 7 | ▪ Continue goal/support activities | ▪ Prepare general activities (e.g., ClassRoomSuite templates, symbols, and word cards)<br>▪ Plan team meetings<br>▪ Evaluate KLINc-storybook for next anchor |
| 8 | ▪ Continue goal/support activities<br>▪ Prepare cycle conclusion | ▪ Update CCP<br>▪ Record sign language and storytelling DVDs |
| 9 | ▪ Assess final performance of each child (i.e., curriculum based vocabulary assessments)<br>▪ Clear out learning environment | ▪ Brainstorm on AAC and related activities for each child<br>▪ Prepare intervention strategies and vocabulary sets adapted for each child for next anchor<br>▪ Evaluate materials and procedures for next anchor<br>▪ Evaluate current anchor |

*Note*: CCP = Communication competence profile.

**Appendix B.** Vocabulary network associated with anchored Kitchen cycle




Eating & drinking
drink (v), eat
cookie, milk, apple
meat, carrot, salt, potato, butter, egg, fries, pancake, rice, sugar, pie, fish
flour
Measures & Time
done
a little, first
empty, full, enough, then, just, how much, long, short

# Early Language Intervention for Children with Intellectual Disabilities: A Neurocognitive Perspective*

*Chapter 6*

**Abstract**

For children with intellectual disabilities (ID), stimulation of their language and communication is often not a priority. Advancements in brain research provide guidelines for early interventions aimed at the stimulation of language and communication skills. In the present study, the effectiveness of an early language intervention which draws upon neurcognitive principles of language processing and language learning was assessed. 10 children participated in the intervention and 18 were followed for control purposes. The intervention group showed greater progress than the control group. The higher learning gains for the intervention group were mostly driven by the non-speaking children. However, the progress of the intervention children slowed down significantly following intervention. An early language intervention such as that studied here can accelerate the language development of children with ID. To maintain the effects, however, the intervention should be prolonged in several settings that focus on consecutive learning (e.g., day-care centers *and* schools).

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*This chapter was published as: Van der Schuit, M., Segers, E., Van Balkom, H., & Verhoeven, L. (2011). Early language intervention for children with intellectual disabilities: A neurocognitive perspective. *Research in Developmental Disabilities, 32*, 705-712.

## Introduction

For many children with intellectual disabilities (ID), their medical, physical, and behavioral problems are of principal priority for caregivers. Little room is left for attention to language development and emergent literacy. Such children can nevertheless acquire complex communication skills and attain high levels of literacy when provided sufficient and appropriate support (Kaiser, Hester, & McDuffie, 2001; Koppenhaver & Erickson, 2003). This lack of attention is quite worrisome, moreover, when it is recognized that most of the problem behavior of such children stems from insufficient language and communication skills (Sigafoos, Arthur, & O'Reilly, 2003; Wacker, Berg, & Harding, 2002). Early interventions to stimulate the language, communication, and emergent literacy of children with ID and efforts to raise the awareness of caregivers with regard to the necessity of such stimulation might therefore be very beneficial (Erickson & Koppenhaver, 1995; Tannock, Girolametto, & Siegel, 1992). New insights from brain research provide guidelines for such early interventions. In the present research, the effectiveness of an early intervention which draws upon neurcognitive principles of language processing and language learning is evaluated.

Recent studies of neurocognition have revealed three essential components for the processing and learning of language: a memory component which provides a basis for the storage and retrieval of lexical information (i.e., the mental lexicon); a unification component which is responsible for the unification (merging, further syntactic processing) of lexically retrieved information; and a control component which relates language to action (Conway & Pisoni, 2008; Hagoort, 2005). A two-year intervention program was specifically developed to address each of the aforementioned components of neurocognition in addition to the developmental strengths and weaknesses of the individual child with ID (Van der Schuit, Segers, Van Balkom, Stoep, & Verhoeven, 2010).

To help with the memory component, multimodal representations (i.e., speech, manual signs, graphic and/or touch symbols) were incorporated into a multi-sensory language intervention. Given that many children with ID also experience sensory deficits (Kaiser et al., 2001), all senses were addressed during language learning to stimulate alternative neural pathways and thereby build denser and stronger neural connections (Leonard & Deevy, 2004; Shams & Seitz, 2008).

To enhance the unification component, a special play and learning environment was arranged in which the children experience various modes of communication. The intervention was designed to improve the children's language development, communication skills, and emergent literacy using a combination of several clearly established and well-documented methods: experiential and meaningful learning inspired by the so-called Reggio Emilia approach (Vakil, Freeman, & Swim, 2003), anchored instruction with learning activities organized around a central theme introduced with an appealing event (Verhoeven & Aarnoutse, 2000), and interactive storytelling (Hargrave & Sénéchal, 2000). Augmentative and Alternative means of Communication (AAC) and computer-based technologies were also incorporated into the intervention in the most natural manner possible. Numerous opportunities for the multimodal training of both receptive and productive language skills were thus supplied. For non-speaking children, the use of AAC provided the necessary adjustments and thereby opportunities for meaningful communication (Romski & Sevcik, 1997).

The control component was included in the intervention to address the large individual differences between children with ID. A continuous effort was made to shift the locus of control from the caregiver to the child and, throughout the intervention, experientially based activities were programmed within the individual child's zone of proximal development (Vygotsky, 1962; 1986). Goal attainment was based on an earlier assessment process with the results recorded in a Communication Competence Profile. In order to develop and tailor the various learning activities to the developmental strengths and weaknesses of each child, dynamic assessment (Tzuriel, 2001) was undertaken during the course of each nine-week anchored learning cycle. The results provided input for the core team meetings of parents, teachers, and therapists to evaluate each child's progress and adjust or set new goals. The parents were involved via the provision of materials to be used in the home environment (e.g., thematically related storybooks, AAC systems such as pictograms and manual sign systems). They also received instruction on how to use the materials and stimulate their child's language and literacy during interactive storytelling and regular daily activities.

The effectiveness of the intervention was investigated via comparison of the development of children in an intervention group versus a control group. The effectiveness of the intervention for groups of speaking versus non-speaking children was further examined via comparison of the mean developmental rates. Finally, to investigate the extent to which the positive effects of the intervention were still present one year after completion of the intervention, a follow-up study of the children in the intervention group was conducted.

## Method

*Participants*

The participants were 28 preschool children with ID between 2 and 6 years of age. All of the children had a nonverbal IQ between 49 and 61 with severe speech and language disabilities. Some of the children also had an autism spectrum disorder (ASD), motor disabilities, and/or sensory disabilities. The children's receptive language age at the start of the study was at least 18 months and they all used no more than ten referential concepts. The primary language in the home was Dutch. The children all attended special day-care centers for children with ID in the Netherlands. All of the parents or guardians provided their informed consent for their child's participation in the study.

The intervention group consisted of 10 children. However, one child from this group could not be retraced a year after the intervention for follow-up measurement. The control group consisted of 18 children who did not participate in the intervention. At the start of the intervention, the groups did not differ with regard to chronological age, developmental age, receptive language age, productive syntax age, or productive vocabulary age. An overview of the group characteristics is presented in Table 1.

Table 1. *Group Characteristics at the Start of the Intervention*

| | *Intervention group* ($n$ = 10) | *Control group* ($n$ = 18) | $p$ [a] |
|---|---|---|---|
| Chronological age | 49.5 months ($SD$ = 15.2) | 43.0 months ($SD$ = 5.9) | .09 |
| Developmental age | 26.9 months ($SD$ = 6.8) | 25.3 months ($SD$ = 3.1) | .35 |
| Receptive language age | 24.6 months ($SD$ = 6.8) | 21.9 months ($SD$ = 6.8) | .26 |
| Productive syntax age | 19.0 months ($SD$ = 7.6) | 21.2 months ($SD$ = 1.9) | .21 |
| Productive vocabulary age | 21.9 months ($SD$ = 11.6) | 20.5 months ($SD$ = 8.1) | .66 |
| Gender | 8 boys; 2 girls | 9 boys; 9 girls | - |
| Aetiology | 3 Down or another syndrome | 5 Down or another syndrome | - |
| | 4 psychomotor retardation | 4 psychomotor retardation | |
| | 2 ASD | 4 ASD | |
| | | 1 epilepsy | |
| | 1 aetiology unknown | 4 aetiology unknown | |

[a] Results of MANOVA on the characteristics for the two groups.

*Materials and procedure*

The nonverbal intelligence, receptive language skills, and productive language skills for all of the children were tested at the start of the intervention and again 12 and 24 months later. To investigate the long-term effects of the intervention, the children in the intervention group were also tested one year after completion of the intervention (i.e., 36 months later).

The standardized Revised Snijders-Oomen Nonverbal Intelligence Test (Tellegen, Winkel, Wijnberg-Williams, & Laros, 2005) was adopted to measure nonverbal intelligence without the use of spoken or written language ($\alpha = .90$). Receptive language was assessed using the Dutch version of the Reynell Test for Receptive Language (Van Eldik, Schlichting, Lutje Spelberg, Van der Meulen, & Van der Meulen, 2004), which is a standardized test to measure both the passive vocabulary and grammatical comprehension of children between 1;2 and 6;3 ($\alpha = .90$). Productive language was assessed by the Schlichting Test for Productive Language(Schlichting, Van Eldik, Lutje Spelberg, Van der Meulen, & Van der Meulen, 2003), with two subtests: one for productive syntactic development ($\alpha = .85$) and one for productive vocabulary ($\alpha = .87$).

The children were individually tested in a quiet room during their time at the day-care centre or school by a trained examiner who was either a speech-language pathologist or a developmental psychologist. The test sessions lasted 30 to 45 minutes, depending upon the child’s abilities and concentration. Up to four sessions were necessary. For most of the children, the sessions were conducted on different days with no more than three weeks in between.

Receptive language was always assessed prior to productive language. Instructions were given verbally, using gestures, or a combination of the two. For the Nonverbal Intelligence Test, the instructions were also provided via demonstration. After each item, the child was given feedback on his or her performance. If necessary, the examiner also demonstrated the correct solution. For both the productive and receptive language measures, answers in manual signs were acceptable. Age equivalents for the child’s total nonverbal intelligence, receptive language, and productive language scores were obtained via reference to the norms presented in the test manuals.

*Statistical Analyses*

A Proportional Change Index (PCI)[1] was computed to measure each child's development in the four areas tested (Wolery, 1983). This was done by comparing the child's rate of development *before* to the intervention to the child's rate of development *during* the intervention. The child's rate of development *before* the intervention was computed by dividing the child's developmental age at the start of the intervention by his or her chronological age at the start. The child's rate of development *during* the intervention was calculated by dividing the developmental gain made during the intervention by the duration of the intervention. If the child makes the same progress during the intervention as before the intervention, the value of the index is one. If the child makes greater or lesser progress during the intervention than before the intervention, the value of the index is above or below one, respectively. In a manner similar to the above, the child's rate of development *after* the intervention was computed to study long-term effects of the intervention. All of the statistical analyses were conducted using SPSS (Version 17.0).

## Results

*Group comparisons*

The mean developmental ages of the children in the intervention and control groups on the four standardized tests administered on three different occasions are presented in Table 2.

The patterns of development for the nonverbal intelligence, receptive language, productive syntax, and productive vocabulary of the two groups of children during the two-year period of intervention are depicted in Figures 1-4.

[1] $\text{PCI} = \left(\frac{\text{developmental gain}}{\text{time in intervention}}\right) \Big/ \left(\frac{\text{pretest developmental age}}{\text{pretest calendar age}}\right)$

Table 2. *Mean Developmental Ages (in months) and Standard Deviations for Intervention versus Control Children on Four Tests Administered on Four Occasions*

| | Time 1 (0m) | | Time 2 (12m) | | Time 3 (24m) | | Time 4 (36m) | |
|---|---|---|---|---|---|---|---|---|
| Test | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Nonverbal cognition | | | | | | | | |
| Intervention | 26.9 | 6.84 | 35.2 | 8.46 | 45.3 | 5.77 | 49.6 | 11.45 |
| Control | 25.3 | 3.08 | 31.8 | 5.55 | 38.5 | 9.02 | - | - |
| Receptive language | | | | | | | | |
| Intervention | 24.6 | 6.79 | 33.5 | 9.90 | 41.2 | 11.54 | 43.6 | 19.42 |
| Control | 21.9 | 6.83 | 27.3 | 8.09 | 33.5 | 11.12 | - | - |
| Productive syntax | | | | | | | | |
| Intervention | 19.0 | 7.57 | 27.2 | 8.98 | 34.7 | 15.65 | 34.1 | 12.80 |
| Control | 21.2 | 1.90 | 24.9 | 5.01 | 27.9 | 8.08 | - | - |
| Productive vocabulary | | | | | | | | |
| Intervention | 21.9 | 11.55 | 30.7 | 11.32 | 41.1 | 12.89 | 41.8 | 18.75 |
| Control | 20.5 | 8.05 | 26.3 | 7.62 | 33.3 | 11.74 | - | - |

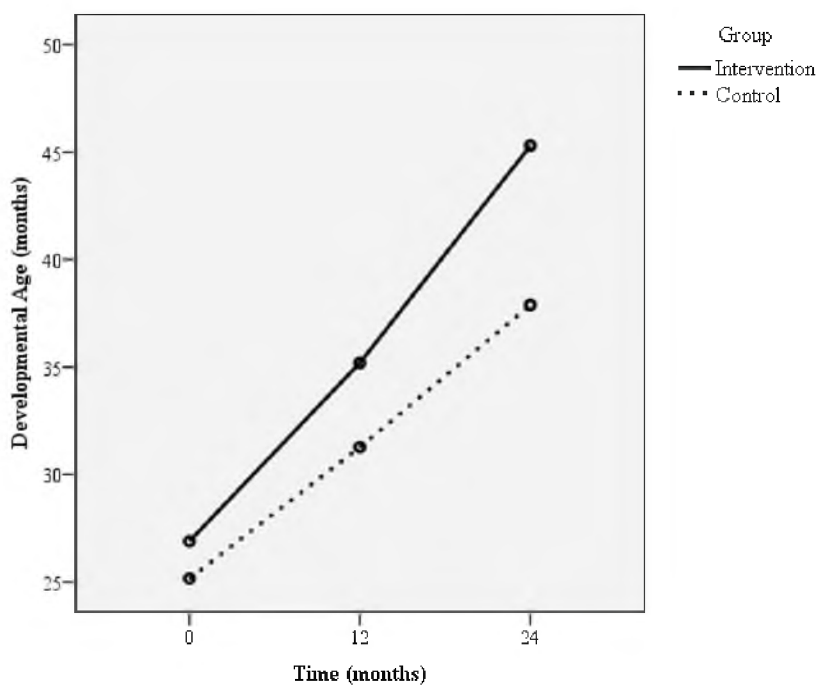


*Figure 1.* Nonverbal intelligence age for the intervention and control groups on three measurement occasions

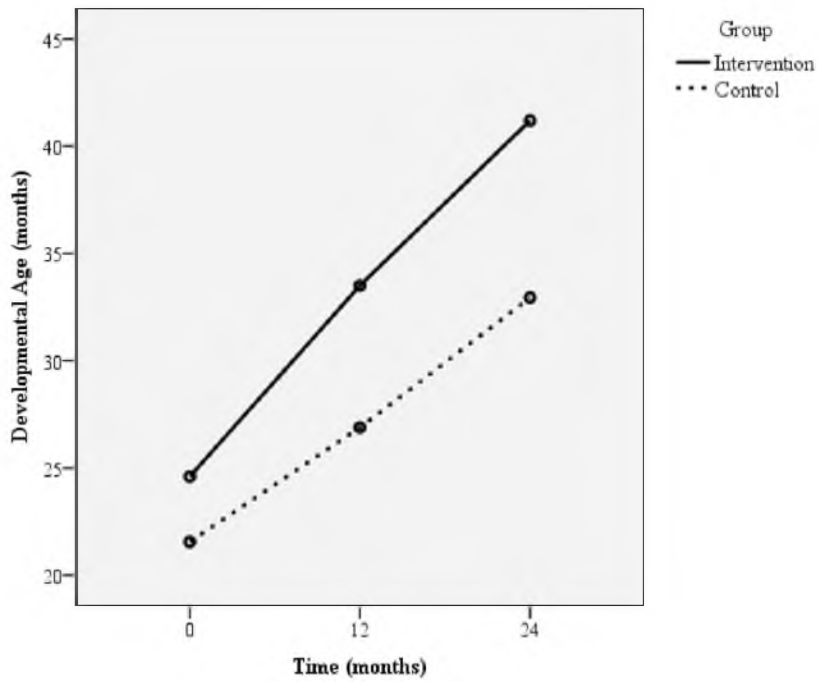


*Figure 2.* Receptive language age for the intervention and control groups on three measurement occasions

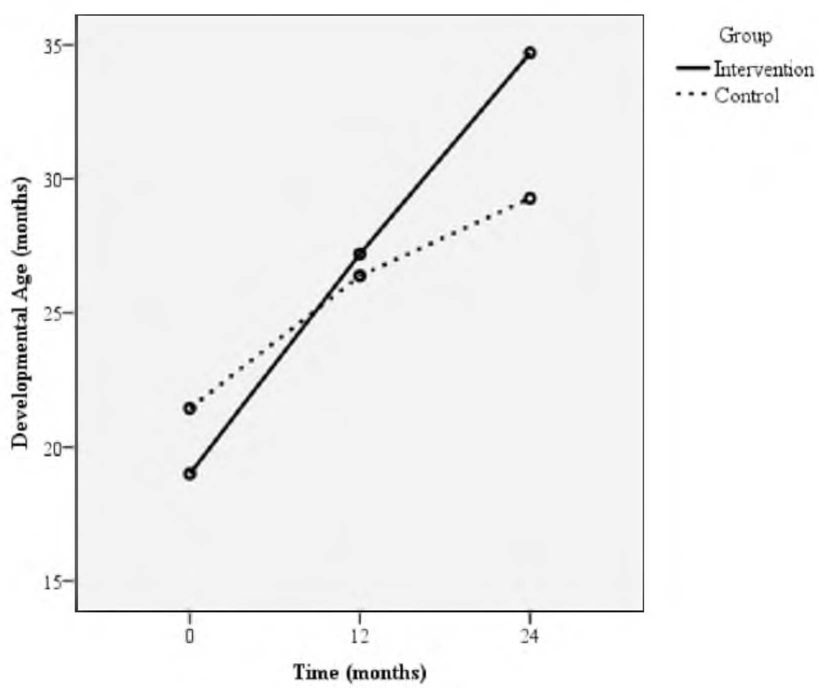


*Figure 3.* Productive syntax age for the intervention and control groups on three measurement occasions

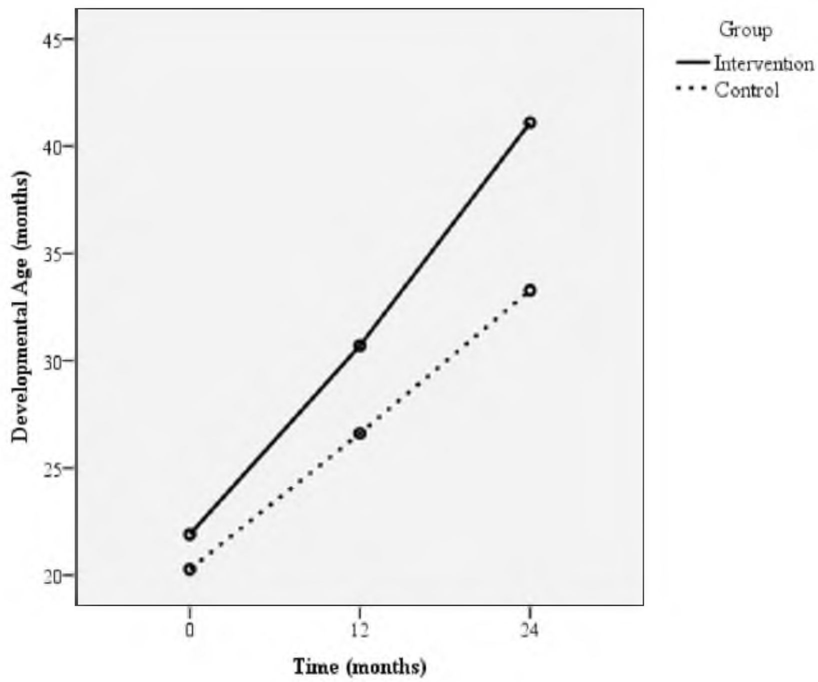


*Figure 4.* Productive vocabulary age for the intervention and control groups on three measurement occasions

The conduct of a multivariate, repeated measures GLM (Van den Bercken & Voeten, 2002) with Time (measurement points 1, 2, and 3) as a within-subjects factor and Group (intervention vs. control) as a between-subjects factor revealed marginally significant Time by Group interactions for receptive language, $F(2, 52) = 3.10$, $p = .054$, $\eta_p^2 = .11$, productive vocabulary, $F(2, 52) = 2.82$, $p = .069$, $\eta_p^2 = .10$, and nonverbal intelligence $F(2, 52) = 2.94$, $p = .061$, $\eta_p^2 = .10$. A significant Time by Group interaction was found for productive syntax, $F(2, 52) = 4.00$, $p < .05$, $\eta_p^2 = .13$. The children in the intervention group showed greater learning gains than the children in the control group.

The children in the intervention and control groups were next divided into speaking versus non-speaking groups to determine if the intervention was possibly more effective for one group than for the other. The difference in the PCIs for the intervention versus control children were then tested for the speaking and non-speaking groups separately. For the *speaking* group, the comparison of the intervention (N=5) and control children (N=7) using independent sample *t*-tests revealed a marginally significant difference in receptive language development, $t(10) = 2.04$, $p = .068$, $d = 1.30$.[2] No significant differences in the development of the other skills (i.e., nonverbal intelligence, productive syntax, and productive vocabulary) by the intervention versus control children in the speaking group were found (all $p$ values > .262). For the *non-speaking* group, the comparison of the intervention (N=5) and control children (N=11) using independent sample $t$-tests revealed significant differences in the development of nonverbal intelligence, $t(4.872) = 2.72$, $p < .05$, $d = 2.03$, and productive vocabulary, $t(4.588) = 2.86$, $p < .05$, $d = 2.25$, with marginally significant differences in the development of productive syntax, $t(4.350) = 2.36$, $p = .073$, $d = 1.93$, and receptive language, $t(14) = 2.08$, $p = .056$, $d = 1.19$. The greater learning gains observed for the intervention group relative to the control group can thus largely be attributed to the marked progress of the non-speaking children in the intervention group.

*Long-term effects*

The long-term effects of the intervention were evaluated via comparison of the mean developmental ages for the children in the intervention group on the standardized tests at the moment of completion of the intervention and one year thereafter. Paired samples $t$-tests showed significant development in the nonverbal intelligence of the children one year after intervention ($t(9) = 2.38$, $p < .05$, $d = 1.59$).[3] For the receptive and productive language tests, no significant differences in the developmental ages of the children on the two measurement occasions were detected (receptive language $t(9) = 0.53$, $p = .609$, $d = 0.35$, productive syntax $t(9) = 0.88$, $p = .400$, $d = 0.59$, productive vocabulary $t(9) = 0.32$, $p = .759$, $d = 0.21$). Thus, in the year following completion of the intervention, the children did not show further development in either their receptive or productive language skills.

The absence of a long-term intervention effect was further investigated by comparison of the children's rate of development *during* the intervention with their rate of development *after* the intervention (i.e., calculation of each child's PCI). One sample $t$-tests were used to test whether the indices differed significantly from one. For all four tests, the developmental indices were found to be significantly smaller than one, which shows the children to make less progress after the intervention than during the intervention (nonverbal intelligence: PCI =

[2] Cohen's $d$ was calculated with the formula, $d = \dfrac{\bar{x}_t - \bar{x}_c}{\sqrt{\dfrac{(n_t - 1)s_t^2 + (n_c - 1)s_c^2}{n_t + n_c}}}$ (cf., Thalheimer & Cook, 2002).

[3] Cohen's $d$ was calculated using the formula, $d = 2t/\sqrt{df}$ (cf. Dunst, Hamby, & Trivette, 2002).

0.398, $t(8) = 2.98$, $p < .05$, $d = 2.11$; receptive language: PCI = -0.006, $t(8) = 2.90$, $p < .05$, $d = 2.05$; productive syntax: PCI = -0.170, $t(8) = 4.04$, $p < .01$, $d = 2.86$; productive vocabulary: PCI = 0.053, $t(8) = 3.29$, $p < .05$, $d = 2.33$). When the children's development *after* the intervention was next compared to their development *before* the intervention, similar rates of development before and after intervention were observed for both nonverbal intelligence (PCI = 0.527, $t(8) = 1.72$, $p = .124$, $d = 1.05$) and receptive language (PCI = 0.011, $t(8) = 1.37$, $p = .207$, $d = 0.97$). For productive syntax and vocabulary, the PCIs were again significantly smaller than one, which shows the children to make less progress after the intervention than before the intervention (productive syntax: PCI = -0.395, $t(8) = 4.01$, $p < .01$, $d = 2.84$; productive vocabulary: PCI = -0.979, $t(8) = 2.31$, $p = .050$, $d = 1.63$).

## Discussion and conclusions

An early intervention which draws upon neurocognitive principles of language processing and language learning and incorporates AAC to promote the language development of preschool children with ID was examined and found to be effective. The children in the intervention group showed greater development than the children in the control group on all measures (i.e., receptive and productive language skills, nonverbal intelligence). A clearly individualized, early language intervention strategy in which the use of AAC is connected to the primary neurocognitive components of lexical memory, unification, and control within a rich learning and play environment produced substantial developmental gains among the children with ID (also see Van der Schuit et al., 2010). The intervention strategy stimulated the children's language and emergent literacy via the development of their vocabularies and the use of AAC in a transactional approach which drew upon experiential learning, anchored instruction, and interactive storytelling. Children must first accumulate a critical mass of productive vocabulary (i.e., about 100 words) in order to kick start more rapid vocabulary development or what is sometimes referred to as a 'vocabulary burst' (Fenson et al., 1994). Simultaneous to this vocabulary burst, children's first word combinations typically appear and the importance of children's vocabulary development for their grammatical development is thus highlighted (Marchman & Bates, 1994). The stimulation of vocabulary growth via the provision of experiential and multimodal language training in the present study stimulated the building of more extensive semantic networks: Higher learning gains were observed for the intervention group on tests of productive vocabulary and productive syntax.

The intervention was particularly effective for the non-speaking children, who showed greater developmental progress than the non-speaking children in the control group, with very large effect sizes (all $d$'s > 1.19). This difference can perhaps be attributed to the natural ways in which AAC was incorporated into the intervention, namely via experiential play, interactive learning activities, AAC-supported story-telling, and daily conversations. For children with ID but also difficulties developing intelligible speech, the use of AAC helps them to communicate better and thereby stimulates both their receptive and productive language (Romski & Sevcik, 1997). The use of AAC created some challenging opportunities for the non-speaking children in the intervention group and encouraged them to become more active communicators and learners. The outcome was increased vocabulary, a broader and denser semantic network, and improved productive language. These improvements may have affected the children's receptive language development as the results of previous studies have shown the active and effective use of AAC for purposes of experiential language learning to indeed stimulate receptive language (Light, 1997).

Follow-up measurements to determine the long-term effects of the present intervention showed the children's receptive and productive language skills to not develop further. The linguistic progress made during the two-year intervention was slowed down significantly. These findings suggest that when the children left the intervention setting and entered a new school environment, this new situation did not prolong the positive intervention effects on language development. The lack of knowledge on how to apply AAC for language and literacy development, the lack of individualized environmental support for the children (i.e., the neurocognitive control component), combined with lower teacher expectations — because the children were now in a group with children who had not participated in the intervention — may have contributed to this lack of sustained development. Expectations certainly determine the manner in which teachers interact with children in addition to the level and types of activities which they offer children (Peeters, Verhoeven, & De Moor, 2009; Stoep, Bakker, & Verhoeven, 2002). The lack of sustained development may also be due to the disappearance of the children's dynamic assessment which was regularly undertaken during the two-year period of intervention to evaluate the children's progress and adjust their individual intervention goals. In fact, dynamic assessment provides extra opportunities to rehearse and reflect upon trained skills, and these opportunities may stimulate further development of the relevant skills (Karpicke & Roediger, 2008). When both the intervention and dynamic assessment stopped, further growth slowed down significantly.

There are some possible limitations on the present study. First, the intervention and control groups were small and heterogeneous. This means that the results must be interpreted with caution. However, the found effect sizes were large. Most studies involving such intensive intervention include small sample sizes of children with complex communication needs (*N* < 10) (e.g., Kim & Lombardino, 1991; Warren, Gazdag, Bambara, & Jones, 1994). The present results also cannot be generalized to children with other age and ability levels. Follow-up studies with larger groups of children, different aged children, and children with different etiologies for their disabilities should thus be undertaken to determine the effectiveness of the present intervention across clinical populations. Furthermore, another limitation is that no follow-up data was collected for the children in the control group. This follow-up data would have been helpful for comparison purposes, however, we expect it to be highly unlikely that the children in the control group would also show the same decrease in developmental growth as was found for the intervention group.

A third possible limitation on the present study is that the use of standardized, norm-referenced tests may not reveal all of the changes in the children's development. Naturalistic observation might therefore be undertaken in addition to testing to obtain a complete picture of the children's language and communication. The administration of a broad range of standardized tests on multiple occasions nevertheless gave us a very detailed picture of the children's developmental abilities for comparison over time.

To conclude, an intervention which was designed to stimulate early language, emergent literacy, and basic communication; take the individual differences between children with ID into consideration; and involve parents was very effective. However, the stimulating effects of the intervention appeared to disappear when the children were no longer in an experiential, multimodal language learning program and missed the assisting impact of AAC. It is therefore important that such an intervention be continued across a longer period of time to help children make the transition from — for example — a day-care centre to a school as children with ID are known to have difficulties with the generalization of learned skills across settings (Beukelman & Mirenda, 2005; Katims, 2000).

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# Chapter 7

The main aim of the research described in this dissertation was to gain insight into the language development of children with ID and the role their environment can play in stimulating this development (i.e., by means of an early intervention). In this chapter, the main findings of the present study will be discussed. First, the results of two studies on the language development of children with ID are considered (i.e., Chapter 2 and 3). Next, the conclusion of Chapter 4, which dealt with the home literacy environment of children with ID, will be described. Then, the effectiveness of an early intervention will be discussed (i.e., Chapter 5 and 6). In addition, the findings of the different studies will be joint in one view, which will revisit the language development of children with ID and the role their communicative environment can play in stimulating this development. Finally, the chapter will end with some limitations and directions for future research, as well as clinical implications that can be derived from the findings of the present study.

## Language processing in children with ID

Chapter 2 describes a study in which the language proficiency of children with ID was investigated in comparison with typically developing children with the same chronological age (CA) and the same mental age (MA). From the results, it can be concluded that children with ID lag behind typically developing children of the same CA, which is in line with previous research (Kaiser, Hester, & McDuffie, 2001; Roberts, Price, & Malkin, 2007). In comparison to an MA matched group of typically developing children, children with ID showed impairments on syntax skills and phonological working memory (WM), but not on vocabulary skills. A second goal of the study was to learn which variables were predictive of vocabulary and syntax skills in children. For the CA group, nonverbal intelligence best predicted vocabulary level, whereas for the MA and the ID group nonverbal intelligence and phonological WM predicted vocabulary level. These results indicate that children with lower vocabulary levels use a different learning strategy, in which they rely more heavily on phonological WM than children with larger vocabularies (Cheung, 1996; Gathercole, Willis, Emslie, & Baddeley, 1992). Furthermore, results showed that for the CA group, vocabulary level was a significant predictor of syntax skills. In contrast, for the ID and MA group both vocabulary and phonological WM best predicted syntax level. From this study, it can be hypothesized that children with ID show specific weaknesses in phonological WM and as a result show a delay in vocabulary development and difficulties with developing syntax skills.

This hypothesis was further investigated in Chapter 3, by examining the longitudinal language development in children with ID and typically developing children. To begin with, it was found that children with ID lag behind typically developing children, and that when nonverbal intelligence level is taken into account differences remain on phonological WM and syntax skills, but not on vocabulary skills. This indicates that children with ID develop vocabulary in pace with their mental age, resulting in delayed vocabulary development, but that both phonological WM and syntax skills are below mental level, which provides further evidence for a deficit in phonological WM and syntax development. Furthermore, results of the structural equation modelling (SEM) analyses showed that for typically developing children phonological WM was not predictive of vocabulary or syntax development from age 4 to 5 years. Also, vocabulary and syntax developed autonomously over the year, as no structural relationships were found between these skills. For the children with ID, phonological WM at age 4 was predictive of vocabulary level at age 5. Furthermore, a positive relationship was found between vocabulary at age 4 and syntax at age 5, which points to a lexical bootstrapping effect with vocabulary level predicting syntax development (Bates & Goodman, 1997; Jones Moyle, Ellis Weismer, Evans, & Lindstrom, 2007). Regarding the role of nonverbal intelligence, results showed that for the typically developing children nonverbal intelligence only predicted phonological WM, vocabulary, and syntax at age 4 and not age 5. However, for the children with ID, nonverbal intelligence predicted the three variables at both ages 4 and 5. Phonological WM at age 4 was no longer predictive of vocabulary at age 5, which indicates that nonverbal intelligence plays a larger role in vocabulary development than phonological WM in children with ID. The structural relationship between vocabulary at age 4 and syntax at age 5 remained after including nonverbal intelligence, showing the tight relationship between vocabulary and syntax development. These results stress the importance of nonverbal intelligence for language development of children with ID, as it was found to play a larger role in predicting language development than phonological WM.

**Home language and literacy environment of children with ID**

The goal of Chapter 4 was to investigate the home literacy environment (HLE) of children with ID in comparison to those of typically developing children of the same chronological age (CA) and the same mental age (MA). The results showed that the HLE of children with ID differed significantly from children in the CA group on almost all aspects (e.g., child's interest in and activities with literacy materials, child's activities during storybook reading, and parental provision of literacy materials and literacy mediation). When compared to children in the MA group, differences in the HLE remained. However, the differences with the MA group were mainly found in child-initiated activities (i.e., child's writing activities, child's storybook reading interest, and child's story, book, and picture orientated activities during storybook reading) and not parent-initiated activities (i.e., provision of literacy materials, and parent literacy mediation). This indicates that parents do adapt their level of communication to the developmental age of their child (cf. Kaiser et al., 2001). But, although parents adapted their HLE activities to the developmental level of the children, the children with ID still showed less literacy activities, which could reflect limited interest in literacy activities of the children themselves.

Also, parents of children with ID did not know what expectations to have for their child's literacy development. The parents of the typically developing children all had high expectations for their child's future reading and writing levels. In contrast, if parents of children with ID had expectations, these were generally lower than those of parents of typically developing children. Expectations parents have, influence children's development to a large extent, because parents with lower expectations engage in less literacy activities with their children (Lee & Groninger, 1994; Weigel, Martin, & Bennett, 2006). The results of our study also showed parents of children with ID to have less storybook reading interest than parents of typically developing children. This means that they read less to their child and have less pleasure in reading to their child. Previous research has found interactive storybook reading to be of crucial importance for children's language and literacy development (Justice & Kaderavek, 2002). The fact that parents of children with ID engaged in less storybook reading with their child further disadvantages children with ID, as they will receive fewer opportunities for language and literacy learning than their typically developing peers.

Several relationships existed between child variables and aspects of the HLE for the children with ID. Correlational analyses showed that the higher the child's intelligence and the better the child's receptive and productive language skills were, the more active the child was with literacy materials and the more story and word oriented activities children showed during storybook reading interactions. Furthermore, the amount of child knowledge about books was related to the amount of literacy materials in the home and the child's activities with these materials. From the results of the correlational analyses, it can be concluded that the HLE of children with ID has an important influence on their language and early literacy development, as was also found for typically developing children (Sénéchal & LeFevre, 2002; Whitehurst & Lonigan, 1998).

## Prospects of early intervention

The efficacy of an early language intervention for preschool children with ID was investigated in Chapter 5 and 6. The intervention was designed to improve the development of language, communication, and early literacy skills of 10 preschool children with ID, by addressing both home and day care settings while also taking the large individual differences between the children into account. First, it was found that children showed more developmental growth during the intervention than before the intervention (Chapter 5). This was especially the case for receptive language abilities and productive vocabulary. Furthermore, the speaking children showed more development on receptive language and expressive syntax than the non-speaking children. No differences, however, were found for productive vocabulary development, and the non-speaking children appeared to catch up with the speaking children at least for vocabulary development towards the end of the intervention. The findings of this study are in line with previous studies, showing that early interventions aimed at the child, parents, or caregivers can be effective in promoting the receptive and productive language development of children with ID (Charlop-Christy, Carpenter, Loc, LeBlanc, & Kellet, 2002; Tannock, Girolametto, & Siegel, 1992). The present study, however, was unique in the use of an intervention that not only aimed at the child, parents, *and* caregivers but also targeted development within the domains of language, communication, *and* early literacy.

Compared to a control group of children with ID who did not participate in the intervention, children in the intervention group showed greater development on receptive and productive language skills and non-verbal intelligence (see Chapter 6). It was also found that the intervention was particularly effective for non-speaking children, as they showed greater developmental progress than the non-speaking children in the control group. For the speaking children, only differences in development of receptive language were found between the intervention and control group. The use of Augmentative and Alternative Communication (AAC) in the intervention may explain the growth of the non-speaking children, as it may have provided them with challenging learning opportunities and helped them to communicate better, which stimulates their receptive and productive language development (Romski & Sevcik, 1997).

A second goal of the study was to determine long-term effects of the intervention. Follow-up measurements of the children in the intervention group a year after the intervention had ended showed the children's receptive and productive language skills to not have developed any further. Although an effort was made to make the transition from the day care centre to the new school environment as easy as possible for the children (i.e., the school and day care setting were combined for the last six months of intervention), children still had difficulties with the transfer and generalization of learned skills across the different settings (Beukelman & Mirenda, 2005; Katims, 2000). This means that when children left the intervention setting and entered a new school environment, this new situation did not prolong the positive intervention effects, and the linguistic progress made during the two-year intervention was slowed down significantly. The lack of knowledge on how to apply AAC for language development, and the lack of individualized environmental support, combined with lower teacher expectations, may have contributed to this lack of sustained effect of the intervention (Beukelman & Mirenda, 2005; Peeters, Verhoeven, & De Moor, 2009).

**Early language acquisition in children with ID revisited**

The present study found evidence that the language acquisition of typically developing children and children with ID can be incorporated in one and the same neurocognitive model of language processing. In this so-called MUC model three components for language learning are discerned: a memory component which provides a basis for the storage and retrieval of lexical information (e.g., vocabulary); a unification component which is responsible for the unification (merging, further syntactic processing) of lexically retrieved information (e.g., syntax); and a control component which relates language to action (e.g., cognitive control like working memory) (Hagoort, 2005). Due to their intellectual disabilities, children with ID may experience difficulties with the control component, which will have an effect on the development of both the memory and unification component. In the present study, nonverbal intelligence was indeed found to have a strong influence on the language development of children with ID. Lower intelligence levels may affect the ways in which children perceive and process (phonological) information, and children with ID are known to differ in their ability to learn and profit from experiences (American Association on Intellectual and Developmental Disabilities [AAIDD], 2010; Katims, 2000). One cognitive domain in which children with ID consistently show delays is WM, which limits long-term learning (Baddeley, 1986; Ellis & Sinclair, 1996). Especially phonological WM seems to be affected in children with ID (Jarrold & Baddeley, 1997; Van der Molen, Van Luit, Jongmans, & Van der Molen, 2007). The present study found further evidence indicating that children with ID are not only delayed in phonological WM, but have specific deficits in phonological WM in comparison with MA-matched typically developing children.

Deficits in phonological WM show an effect on the development of the memory and unification component of the MUC model, as the present study found tight relationships between phonological WM and both vocabulary and syntax skills, which is in accordance with previous research (Jarrold, Baddeley, Hewes, Leeke, & Phillips, 2004; Miolo, Chapman, & Sindberg, 2005). This means that the limitations children with ID have in phonological WM may make it harder for them to abstract structured patterns from the sequences heard, which may result in difficulties with implicitly learning the grammatical rules from the language (Conway & Pisoni, 2008). Productive syntax development will also be hindered by difficulties in phonological WM, because in order to be able to produce a multi-word utterance the WM needs to maintain a certain amount of words active while they are unified into a grammatically correct sentence (Hagoort, 2005). In a study of Adams and Gathercole (1995), children who have better phonological WM skills have indeed been found to produce longer and grammatically more complex sentences.

The difficulties in phonological WM also have a restrictive influence on vocabulary development of children with ID, as phonological WM was found to be predictive of vocabulary skills. This will not only result in smaller vocabulary sizes for children with ID, but can also lead to a less adequate (phonological) storage of vocabulary in the mental lexicons of children. The mental lexicon consists of networks of concepts and interconnected meaning associations with various semantic, syntactic, and phonological relationships, which children build up while acquiring words and greater experiential knowledge of the world (Aitchison, 1994). Children with ID can be assumed to develop less elaborate and more superficially organized mental lexicons than typically developing children (Leonard & Deevy, 2004). Weak links between the various components of the mental lexicons of children with ID will hinder further vocabulary development, and will also have an effect on further syntactical development, as vocabulary level is predictive of syntactic development.

In the present study, a prolonged lexical bootstrapping effect was observed in children with ID, with vocabulary level predicting syntax development (Bates & Goodman, 1997; Marchman & Bates, 1994). In typical development, lexical bootstrapping effects are observed until 2;6 years of age, after which syntactic bootstrapping effects are observed, with syntactic knowledge facilitating lexical development (Jones Moyle et al., 2007). The children with ID in the present study had a developmental age of 2;8 years, from which it was expected that syntactic bootstrapping effects would be observed. The finding of a lexical bootstrapping effect at this point of development can be caused by the less elaborate and more superficially organized mental lexicons in children with ID (Leonard & Deevy, 2004), which will hinder their syntactic development. Children with ID may simply need a larger critical mass of vocabulary and thus more models for syntactic development to be initiated. Another explanation for the prolonged lexical bootstrapping effect in children with ID can be that they find it more difficult to use syntactic cues to interpret word meaning, which will hinder syntactic knowledge to bootstrap lexical development (Jones Moyle et al., 2007).

The language development of children with ID is further disadvantaged when it comes to their communicative environment. This communicative environment plays an important role in language development of young children (Hart & Risley, 1995), and children with ID may depend to a greater extent on their communicative partners, as they often lack skills for effective early communication (e.g., joint attention skills) (Kaiser et al., 2001). With regard to the neurocognitive model, it is the control component that for a large part can be supported by the child's communicative partners. This 'external' control can facilitate language learning in children with ID. For example, parents who expand their child's utterances with more complex vocabulary, greater information, and/or more complete syntax will optimize the language learning and communicative competence of their child to a greater extent (Kaiser, Hancock, & Hester, 1998; Romski, Sevcik, & Adamson, 1999). Especially stimulating children within their 'zone of proximal development' will have a positive effect on the development of targeted skills. The zone of proximal development is defined as the distance between a child's "actual developmental level as determined by independent problem solving" and the higher level of "potential development as determined through problem solving under adult guidance" (Vygotsky, 1978, p.86). This means that parents and teachers should provide children with activities just above their current competence level in order to provide them with challenging learning opportunities, which will stimulate further language development. The present study has shown, however, that the language environment of children with ID (i.e., their HLE) is often adjusted to the developmental level of the child, which may result in less stimulating interactions for language development, because in this way activities are not in children's zone of proximal development and thus do not stimulate a higher level of performance in children.

Furthermore, the present study has shown that the communicative environment of children with ID can effectively be adapted by means of an early intervention. In this way, children's language development can be stimulated through adjusting the 'external' control.

Within the intervention a continuous effort was made to shift the locus of control from caregiver to child, to provide children with several modalities to perceive and produce information (e.g., visual and verbal), and to develop activities within the child's zone of proximal development. The central goal of the intervention was to stimulate children's language development through vocabulary development and the use of AAC. Children need to develop a critical mass of 50-100 productive vocabulary items in the mental lexicon (i.e., memory), which will then give an impulse to a more rapid vocabulary growth and the start of grammatical development (i.e., unification). The stimulation of vocabulary growth through adapted, child-directed multimodal language input in an experiential play and learning environment (enhancing control) resulted in the building of more extensive semantic networks for the children. As a consequence, high learning gains were found on productive vocabulary and syntax for children in the intervention group.

## Limitations and Future Directions

The present study has its own limitations. First, the group of children with ID consisted of a heterogenic group of children with different etiologies (e.g., Down syndrome, Velo-cardio-facial syndrome, or an unknown cause) or co-morbid disabilities (e.g., autism spectrum disorders, attention deficit hyperactivity disorder, or epilepsy). An important reason for studying children with ID as one group was that in this way the influence of different intelligence levels could be studied more closely. Furthermore, dividing the group into subgroups based on etiology would have resulted in rather small groups, from which it is difficult to draw conclusions. Also, the range of etiologies in this sample most closely resembles the group of children represented in day-care centers for children with disabilities in the Netherlands. The results of this study are therefore of importance for practitioners working with young children in intervention services. Future research could, however, study whether there are subgroups of children with ID who show specific profiles on development of the various language domains.

Although the present study has shown the HLE of children with ID to differ from those of typically developing children, more research is needed to find out which language and literacy opportunities children with ID receive at home. In the study described in Chapter 4, the HLE was examined by means of parent questionnaires. These questionnaires provided valuable information about the way parents perceive the aspects of the HLE measured. However, parents may have had the tendency to give socially acceptable answers and thus may have withheld negative beliefs they had about literacy or may have increased the amount of literacy activities done with the children. Future research should gather more information on the actual language and literacy activities parents and children perform. This could be studied by means of observations in the home environment or in-depth interviews with parents. In this way, it can for example be investigated what beliefs parents have about language and literacy development of their child, what amount and type of activities parents do and in which way children react to these activities.

The results of the present study indicate that children with ID do not develop elaborate mental lexicons with strong links between the various components like typically developing children do. However, the task that was used to measure vocabulary in the present study only measured productive vocabulary size and gave no detailed information about the depth of the mental lexicon of the children. It is therefore important that tasks are developed that can investigate how the mental lexicons of children with ID are constructed and to what extent links exist between the various components. Also, recent developments in brain research can be used in studying the language development of children with ID. For example, neuroimaging studies can shed further light on the question whether brain structures that are thought to be of importance for typical language development, show the same activity in children with ID (Davids, 2009; Hagoort, 2005).

The early intervention studied in Chapters 5 and 6 was found to be effective in stimulating the language development of children with ID. It should be kept in mind that the number of participating children in this efficacy study was small ($N$=10) and heterogeneous, which means that the results should be interpreted with some caution. However, all children showed an increase in developmental growth during the intervention period and the effect sizes were large. Furthermore, the data of the present study was collected parallel to the development of the intervention and should thus be viewed as formative. More data using the same intervention should thus be collected in the future. These future studies should not only include larger numbers of children, but also children with different ages and different etiologies, in order to determine the effectiveness of the intervention across clinical populations.

## Clinical Implications

From the present study several implications for clinical practice can be derived. With regard to the language development of children with ID, it should be noted that early language interventions should target all language domains, as these are highly interdependent during early language development. An immersive intervention that takes the large individual differences between children with ID into account and stimulates the children's language via the development of their vocabularies and the use of AAC can result in significant learning gains in both cognitive and language skills among children with ID. It is, however, important that language and literacy instruction for children with ID is concrete, experiential and meaningful, is continued for a longer period of time, and is carried out in several different situations (e.g., home and day care settings), to help children make the transition from — for example — a day care centre to a school, as children with ID have difficulties with transfer and generalization of learned skills across settings (Beukelman & Mirenda, 2005; Katims, 2000).

Parents of children with ID do not know what to expect for their children's language and literacy development. They should therefore be informed about the possibilities of their child to develop advanced language and literacy skills, and the role the environment can play in stimulating the development of these skills. Therefore, it is important that language and literacy development becomes an important goal for parents of children with ID, which often turns out not to be the case (Marvin & Mirenda, 1993; Trenholm & Mirenda, 2006). Parents should then be guided with ways to stimulate their children's language and literacy development. One important way is by making use of interactive storybook reading through AAC, as the quality of storybook reading sessions with the use of AAC has been found to affect language and early literacy development of both typically developing children and children with ID (Hargrave & Sénéchal, 2000; Justice & Kaderavek, 2002; Peeters, Verhoeven, De Moor, Van Balkom, & Van Leeuwe, 2009). During interactive storybook reading, parents do not just read a book cover to cover, but make use of a more interactive way of reading and try to let their child take a more active role in the interaction (Crowe, Norris, & Hoffman, 2004; Hargrave & Sénéchal, 2000). For example, stories are related to experiences in the daily lives of the children or re-enacted by the child and the parent. In the present study, children with ID showed less interest in literacy activities and were less active during storybook reading as compared with the typically developing children. To enhance children's activity during storybook reading, AAC (e.g., objects, pictograms, and signs) can be used, which will give children the opportunity to take initiatives, to functionally react on the story, to ask questions or retell the story through augmented means.

When developing early interventions for children with ID, it is important that individual differences between children are taken into account. Interventions should be tailored to the developmental strengths and weaknesses of the individual child, and a way to closely monitor progress and address individual needs is by making use of dynamic assessment (DA) techniques (Tzuriel, 2001). DA is a flexible, nonstandardized assessment technique, which explores the learning process of a child, by gathering information about the type of support needed to change the child's behavior (Kublin, Wetherby, Crais, & Prizant, 1998). The focus is on what a child can do or what the child has potential to do, where more traditional, static assessments may only reveal what a child cannot do. DA is based on Vygotsky's concept of the "zone of proximal development" (Tzuriel, 2001) and compares a child's assisted and unassisted performances, by systematically introducing and withdrawing adult guidance (prompts) to determine if a child's performance can be improved through instruction (Snell & Loncke, 2002). The outcome of DA is a description of developmental strengths of a child (i.e., the child's zone of proximal development) and it also provides information about the child's learning strategies and responsiveness to the intervention (Olswang, Bain, & Johnson, 1992). DA allows for the development of a clearly, individualized intervention program in which progress of the child is evaluated regularly, intervention goals are adjusted when necessary, and activities are created in line with a child's zone of proximal development. DA by itself may also stimulate further development, as it provides the child with extra opportunities to rehearse and reflect upon trained skills (Karpicke & Roediger, 2008).

Especially for non-speaking children with ID it is important that, in order to achieve greater learning gains, interventions should incorporate a great variety and intensity of use of AAC during daily life situations (e.g., more frequent use during interactive storybook reading, social play, and daily life activities). Introducing AAC stimulates receptive language understanding and it has proven not to impede verbal speech development (Light, 1997; Millar, Light, & Schlosser, 2006). On the contrary, it may provide nonspeaking children with challenging learning opportunities and help them to communicate better, which stimulates both their receptive and productive language development (Romski & Sevcik, 1997). Furthermore, as children with ID have been found to have difficulties in phonological WM, AAC can be used not only with children who require it for output but also as an input channel to support transient auditory information (e.g., speech) with more stable, visual-graphic information (e.g., pictograms, drawings) and objects as tangible symbols. Moreover, it is important that parents, caregivers, and teachers are coached in prompting lexical and grammatical development via the adjustment of the language input (with AAC) and in providing more adequate models of adapted language use for children (Light, 1997; Paul, 1997). This way of working perfectly combines with interactive storybook reading and experiential language learning, as was found in the present study. Moreover, the present study has resulted in the development of an evidence-based clinical early intervention program for young children with complex communication needs, called the KLIN*c* Studio ('Kids Learning to take INitiatives in *c*ommunication') (Stoep, Van Balkom, Luiken, Snieders, & Van der Schuit, 2008; Van der Schuit, Segers, Van Balkom, Stoep, & Verhoeven, 2010)

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# Summary

In the present study the language development of children with intellectual disabilities (ID) was investigated. Children with ID often experience delays in language development, however, varying language levels and atypical developmental trajectories in children with ID raise the question of how these children acquire language skills, and what role different levels of intelligence and other cognitive factors play in this development. Furthermore, although children acquire language in interaction with their communicative environment, for children with ID little is known about these environments. Even less is known about the best ways to adjust these children's environment by means of an early intervention, in order to enhance their language development. To gain more insight into these issues for children with ID, the present study investigated the language development of children with ID longitudinally and examined the effectiveness of an early language intervention for children with ID. The first chapter of this thesis gives an introduction in the language development of typically developing children and children with ID, and contains the research questions and the design of the present study. Chapters 2 and 3 describe two studies on the language development of children with ID in comparison with typically developing children. In Chapter 4 the home literacy environment (HLE) of children with ID is studied. Chapters 5 and 6 report on the efficacy of an early language intervention for children with ID. Finally, Chapter 7 provides a general conclusion, and a number of clinical implications that can be derived from the main findings.

In Chapter 2, the language proficiency of 58 five-year-old children with ID was examined in comparison with 42 typically developing children with the same chronological age (CA) and 42 typically developing children with the same mental age (MA). Recent neurocognitive studies revealed a tripartite structure of language processing, with a memory (i.e., vocabulary), unification (i.e., syntax), and control (i.e., phonological working memory (WM)) component. It was studied to what extent children with ID experience difficulties on these components in comparison to typically developing children with the same CA and the same MA. Results showed that the children with ID lag behind typically developing children of the same CA on all components, and that in comparison to the MA group, children with ID showed specific impairments on syntax and phonological WM, but not on vocabulary. Furthermore, it was investigated which precursors predicted vocabulary and syntax level for all three groups of children separately. For the ID and MA group, vocabulary was predicted

by nonverbal intelligence and phonological WM, whereas nonverbal intelligence best predicted vocabulary level for the CA group. Furthermore, it was found that for the ID and MA group both vocabulary and phonological WM best predicted syntax level. However, in the CA group only vocabulary was a significant predictor of syntax. The results of this study thus reveal that children with ID show specific weaknesses in phonological WM in comparison with MA-matched typically developing children. As a result of these difficulties in phonological WM, children with ID may experience a delay in vocabulary development and difficulties with developing syntax.

In Chapter 3, the longitudinal language development from age 4 to 5 years of 50 children with ID and 42 typically developing children was investigated. The study was designed to shed more light on the respective roles of phonological WM and nonverbal intelligence in vocabulary and syntax development. The results showed that children with ID lag behind typically developing children, and that when nonverbal intelligence level is taken into account differences remain on phonological WM and syntax skills, but not on vocabulary skills. This indicates that children with ID develop vocabulary in pace with their mental age, but that both phonological WM and syntax skills are below mental level. Via structural equation modelling (SEM) the longitudinal relationships between nonverbal intelligence, phonological WM, vocabulary, and syntax were investigated. Results showed that, for the typically developing children, nonverbal intelligence predicted phonological WM, vocabulary and syntax at age 4 and not at age 5. Also, no structural relationships were found between phonological WM, vocabulary and syntactic development from age 4 to 5, which indicates that these skills develop quite autonomously in typical development at this age. For the children with ID, nonverbal intelligence predicted phonological WM, vocabulary and syntax at both age 4 and 5. Furthermore, syntax at age 5 was also predicted by vocabulary at age 4 in children with ID, which shows the tight relationship between vocabulary and syntactic development and points to the importance of vocabulary for syntactic development. With nonverbal intelligence included in the model, phonological WM at age 4 was no longer predictive of vocabulary at age 5, which indicates that nonverbal intelligence plays a larger role in vocabulary development than phonological WM in children with ID. The results of this study thus further stress the importance of nonverbal intelligence for language development of children with ID.

The home literacy environment (HLE) of children with ID in comparison to children without disabilities was examined in Chapter 4. Little is known about the HLE of children with ID, and because the HLE plays an important role in the development of language and literacy skills, it is important to gain more insight into the HLE of children with ID. Parent questionnaires concerning aspects of the HLE were used to investigate differences between 48 children with ID, 107 typically developing children of the same CA, and 36 typically developing children of the same MA. The results showed that the HLE of children with ID differed from that of children in the CA group on almost all aspects. When compared to children in the MA group, differences in the HLE remained. However, these differences mainly concerned child-initiated activities (e.g., child's writing activities, and child's storybook reading interest) and not parent-initiated activities (e.g., provision of literacy materials, and parent literacy mediation). Furthermore, for the children with ID, correlations were computed between aspects of the HLE and children's nonverbal intelligence, speech intelligibility, language, and early literacy skills. Results showed that children's literacy activities were positively related with their level of nonverbal intelligence, productive syntax and vocabulary, and book orientation skills. Children's active involvement during storybook reading was also related to their level of nonverbal intelligence, receptive language, productive syntax and vocabulary, book orientation and rapid naming of pictures. The amount of literacy materials parents provide in the home, was related to a higher level of productive syntax and book orientation of children. From the results of the present study, it can be concluded that the intellectual disabilities of the children were the main cause of the differences found in the HLE between children with ID and children without disabilities. Furthermore, the HLE of children with ID has an important influence on their language and early literacy development, as was also found for typically developing children. However, parents of children with ID were found to adapt their level of communication to the developmental level of their child, which may not always be the most stimulating for the child's development.

In Chapter 5, the effectiveness of an early language intervention that addresses both home and day care for children with ID while also taking the large individual differences between the children into account, was examined. The intervention was designed to improve the development of language, communication, and early literacy skills of 10 preschool children with ID. The focus in the anchor-based intervention program was on the stimulation of children's language development through vocabulary development and the use of Augmentative and Alternative Communication (AAC). Results showed all of the children to make more developmental progress during the intervention than before the intervention, especially on receptive language abilities and productive vocabulary. Furthermore, results showed that the group of speaking children showed greater development in the domains of receptive language and productive syntax than the group of non-speaking children. However, no differences were found for productive vocabulary development, and the non-speaking children appeared to catch up with the speaking children at least for vocabulary development at the end of the intervention. Findings of this study indicate that the use of an early intervention aimed at the child, parents, and caregivers can be effective in promoting the receptive and productive language development of preschool children with ID.

Chapter 6 expands the efficacy study of the early language intervention described in Chapter 5, by comparing the development of the 10 children in the intervention with the development of a control group of 18 children who did not participate in the intervention. The results of the study revealed greater development on receptive and productive language skills and non-verbal intelligence for children in the intervention group than children in the control group. These higher learning gains for the intervention group were mostly driven by the non-speaking children, because they showed greater developmental growth than the non-speaking children in the control group. For the speaking children, only differences in receptive language development were found between the intervention and control group. Follow-up measurements of the children in the intervention group one year after the intervention had ended, showed the progress of the intervention children to slow down significantly. The results of this study thus reveal that an early language intervention can accelerate the language development of children with ID. However, results also stress the importance of continuation of the intervention for a longer period of time and in several settings that focus on consecutive learning (e.g., day-care centres and schools), to maintain positive learning effects.

Finally, in Chapter 7 the findings of the studies are described separately, and then integrated in light of a neurocognitive model of language processing and learning (Hagoort, 2005). The general findings indicate that children with ID show a delay in vocabulary development consistent with their developmental level, but that they experience specific weaknesses in the development of phonological WM and syntax skills. Moreover, parents of children with ID were found to adapt their level of communication and activities to the developmental level of the child, which may result in less stimulating interactions for language development, because in this way children are not stimulated to develop higher language levels. The communicative environment of children with ID can, however, be effectively adjusted by means of an early intervention. Stimulating children's language development through vocabulary development and the use of AAC, results in significant learning gains in children with ID. Chapter 7 ends with some suggestions for future research and clinical implications that can be derived from the main findings. With regard to the clinical implications, it is important that early language interventions take an individually tailored focus on communicative competence (being a combination of social, strategic, operational, and linguistic competence), target all developmental core domains that influence language development, include AAC, environmental adjustments, parental guidance and instruction, and that language activities are concrete, experiential and meaningful, continued for a longer period of time, and carried out in several different situations (e.g., home and day care settings), to help children transfer and generalize learned skills across settings.

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# Samenvatting

In de huidige studie is de taalontwikkeling van kinderen met een verstandelijke beperking onderzocht. De taalontwikkeling van kinderen met een verstandelijke beperking is over het algemeen vertraagd, maar er is een grote variatie in behaalde taalvaardigheden en kinderen laten regelmatig een atypische ontwikkeling zien. Hierdoor rijst de vraag hoe kinderen met een verstandelijke beperking taalvaardigheden ontwikkelen en welke rol intelligentie en andere cognitieve factoren daarbij spelen. Daarnaast is weinig bekend over de invloed van de communicatieve omgeving van kinderen met een verstandelijke beperking op hun taalontwikkeling, ondanks dat kinderen taal verwerven in interactie met hun omgeving. Nog minder is bekend over het stimuleren van de taalontwikkeling van deze kinderen door middel van het aanpassen van de omgeving met behulp van een vroege interventie. Om meer zicht te krijgen op deze kwesties, wordt in dit proefschrift de taalontwikkeling van kinderen met een verstandelijke beperking longitudinaal onderzocht en wordt de effectiviteit van een vroege taalinterventie onderzocht. Het eerste hoofdstuk van dit proefschrift geeft een introductie in hetgeen reeds bekend is over de taalontwikkeling van zich normaal ontwikkelende kinderen en kinderen met een verstandelijke beperking. Dit hoofdstuk behandelt tevens de onderzoeksvragen en de opzet van het onderzoek. Hoofdstukken 2 en 3 beschrijven twee studies die de taalontwikkeling van kinderen met een verstandelijke beperking onderzoeken in vergelijking met zich normaal ontwikkelende kinderen. In hoofdstuk 4 wordt de geletterde thuisomgeving van kinderen met een verstandelijke beperking onderzocht. Hoofdstukken 5 en 6 rapporteren over de effectiviteit van een vroege taalinterventie voor kinderen met een verstandelijke beperking. Het laatste hoofdstuk, hoofdstuk 7, beschrijft de algemene conclusies die getrokken kunnen worden naar aanleiding van de verschillende studies uit dit proefschrift en geeft een aantal praktische en klinische implicaties die volgen uit de bevindingen van de onderzoeken.

In hoofdstuk 2 worden de taalvaardigheden van 58 vijfjarige kinderen met een verstandelijke beperking onderzocht in vergelijking met 42 zich normaal ontwikkelende kinderen met dezelfde kalenderleeftijd (KL) en 42 zich normaal ontwikkelende kinderen met dezelfde ontwikkelingsleeftijd (OL). Recent neurocognitief onderzoek laat een driedelige structuur voor taalverwerking zien, met een lexicaal geheugen (i.e., woordenschat), unificatie (i.e., syntax) en controle (i.e., fonologisch werkgeheugen (WG)) component. Het doel van het onderzoek was na te gaan in hoeverre kinderen met een verstandelijke beperking problemen hebben op deze drie componenten in vergelijking met zich normaal ontwikkelende kinderen met dezelfde KL en dezelfde OL. Uit de resultaten bleek dat de kinderen met een verstandelijke beperking achterblijven bij zich normaal ontwikkelende kinderen met dezelfde KL op alledrie de componenten. In vergelijking met zich normaal ontwikkelende kinderen met dezelfde OL laten kinderen met een verstandelijke beperking specifieke achterstanden zien op het gebied van fonologisch WG en syntax, maar niet op het gebied van woordenschat. Daarnaast werd onderzocht welke vaardigheden woordenschat en syntax voorspelden voor de drie groepen kinderen apart. Voor zowel de kinderen met een verstandelijke beperking en de OL-groep werd woordenschat voorspeld door non-verbale intelligentie (IQ) en fonologisch WG. Voor de KL-groep werd gevonden dat woordenschat enkel werd voorspeld door non-verbaal IQ. Verder werd gevonden dat in de KL-groep syntax werd voorspeld door woordenschat, terwijl voor de kinderen met een verstandelijke beperking en de OL-groep zowel woordenschat en fonologisch WG het syntactisch niveau voorspelden. De resultaten van deze studie laten dus zien dat kinderen met een verstandelijke beperking met name op het gebied van fonologisch WG zwakker zijn dan zich normaal ontwikkelende kinderen met dezelfde OL. Deze tekorten in het fonologisch WG kunnen leiden tot achterstanden in de woordenschatontwikkeling en tot problemen in de syntaxontwikkeling.

In hoofdstuk 3 is de longitudinale taalontwikkeling van 50 kinderen met een verstandelijke beperking en 42 zich normaal ontwikkelende kinderen van 4 tot 5 jaar onderzocht. Met deze studie werd beoogd meer zicht te krijgen op de rol van zowel het fonologisch WG als het non-verbaal IQ in de ontwikkeling van woordenschat en syntax. De kinderen met een verstandelijke beperking hadden een algehele achterstand op de zich normaal ontwikkelende kinderen. Wanneer gecontroleerd werd voor het non-verbaal IQ bleek tussen de twee groepen echter geen verschil meer te bestaan voor woordenschat, maar nog wel voor fonologisch WG en syntactische vaardigheden. Dit duidt er op dat de woordenschat van kinderen met een verstandelijke beperking zich in de lijn van het mentale niveau ontwikkelt, maar dat zowel fonologisch WG als syntax achterliggen op het mentale niveau. Door middel van *structural equation modeling* (SEM) zijn vervolgens longitudinale relaties tussen non-verbaal IQ, fonologisch WG, woordenschat en syntax onderzocht. Voor de zich normaal ontwikkelende kinderen werd gevonden dat non-verbaal IQ het niveau van fonologisch WG, woordenschat en syntax op 4-jarige leeftijd voorspelt, maar niet op 5-jarige leeftijd. Verder werden geen structurele relaties gevonden tussen fonologisch WG, woordenschat en syntax ontwikkeling van 4 naar 5 jaar, wat erop wijst dat deze vaardigheden zich bij zich normaal ontwikkelende kinderen van deze leeftijd redelijk autonoom ontwikkelen. Voor de kinderen met een verstandelijke beperking bleek non-verbaal IQ het niveau van fonologisch WG, woordenschat en syntax op zowel 4 als 5 jaar te voorspellen. Daarnaast bleek woordenschat op 4-jarige leeftijd het niveau van syntax op 5-jarige leeftijd te voorspellen. Dit duidt op een sterke relatie tussen woordenschat- en syntaxontwikkeling en het geeft het belang aan van een goede woordenschat voor de syntactische ontwikkeling. Wanneer non-verbaal IQ werd meegenomen in de analyses, bleek fonologisch WG op 4-jarige leeftijd geen invloed meer te hebben op het niveau van woordenschat op 5 jaar. Dit duidt er op dat non-verbaal IQ een belangrijkere rol speelt in de woordenschatontwikkeling dan fonologisch WG. De resultaten van dit onderzoek benadrukken dan ook het belang van het non-verbaal IQ voor de taalontwikkeling van kinderen met een verstandelijke beperking.

De geletterde thuisomgeving van kinderen met een verstandelijke beperking wordt vergeleken met de thuisomgeving van zich normaal ontwikkelende kinderen in hoofdstuk 4. Er is slechts weinig bekend over de geletterde thuisomgeving van kinderen met een verstandelijke beperking, terwijl juist deze thuisomgeving een belangrijke rol speelt in de ontwikkeling van taal en beginnende geletterdheid van kinderen. Oudervragenlijsten over aspecten van de geletterde thuisomgeving werden gebruikt om verschillen in de thuisomgeving van 48 kinderen met een verstandelijke beperking, 107 zich normaal ontwikkelende kinderen met dezelde KL en 36 zich normaal ontwikkelende kinderen met dezelfde OL, te onderzoeken. De resultaten lieten zien dat de geletterde thuisomgeving van kinderen met een verstandelijke beperking op bijna alle aspecten verschilt met die van de KL-groep. In vergelijking met de kinderen in de OL-groep bleken er met name verschillen te zijn in de activiteiten die de kinderen zelf ondernemen (bijv. schrijfactiviteiten van de kinderen en de interesse van kinderen in het lezen van prentenboeken) en niet op het gebied van activiteiten die ouders ondernemen (bijv. het aanbod van geletterdheidsmaterialen en geletterdheidactiviteiten door ouders). Verder werden voor de kinderen met een verstandelijke beperking correlaties berekend tussen aspecten van de geletterde thuisomgeving en het non-verbaal IQ, spraakverstaanbaarheid, taalvaardigheid en beginnende geletterdheid van de kinderen. De resultaten lieten zien dat geletterdheidactiviteiten die kinderen doen positief gerelateerd zijn aan het niveau van non-verbaal IQ, productieve syntax en woordenschat, en boekoriëntatie. De mate waarin een kind actief betrokken was tijdens het voorlezen was tevens gerelateerd aan het niveau van non-verbaal IQ, taalbegrip, productieve syntax en woordenschat, boekoriëntatie en het snel kunnen benoemen (i.e., rapid naming) van plaatjes. De hoeveelheid geletterdheidsmaterialen die thuis aanwezig zijn, was gerelateerd aan het niveau van productieve syntax en boekoriëntatie van de kinderen. Uit de resultaten van dit onderzoek kan geconcludeerd worden dat de verstandelijke beperkingen van de kinderen de belangrijkste veroorzaker waren van de verschillen in geletterde thuisomgeving tussen de kinderen met een verstandelijke beperking en zich normaal ontwikkelende kinderen. Daarnaast bleek de geletterde thuisomgeving van kinderen met een verstandelijke beperking een grote invloed te hebben op hun taalontwikkeling en vroege geletterdheid. Ouders van kinderen met een verstandelijke beperking blijken hun communicatie aan te passen aan het ontwikkelingsniveau van hun kind, wat niet altijd resulteert in de voor de ontwikkeling van de kinderen meest stimulerende omgeving.

In hoofdstuk 5 is de effectiviteit van een vroege taalinterventie onderzocht. Deze interventie was gericht op zowel de thuisomgeving als het kinderdagverblijf en probeerde rekening te houden met de grote individuele verschillen tussen kinderen met een verstandelijke beperking. De interventie was ontwikkeld om de ontwikkeling van taal-, communicatie- en vroege geletterdheidvaardigheden van 10 kleuters met een verstandelijke beperking te stimuleren. De focus van het ankergestuurde interventieprogramma was gericht op het stimuleren van de taalontwikkeling door middel van woordenschatontwikkeling en de inzet van Ondersteunde Communicatie (OC). Uit de resultaten bleek dat alle kinderen tijdens de interventie een grotere ontwikkelingsgroei hadden dan in de periode voor de interventie, vooral op het gebied van taalbegrip en productieve woordenschat. Verder lieten de resultaten zien dat de sprekende kinderen een grotere ontwikkelingsgroei doormaakten op het gebied van taalbegrip en productieve syntax dan de niet-sprekende kinderen. Geen verschillen werden echter gevonden op het gebied van productieve woordenschat en de niet-sprekende kinderen leken aan het eind van de interventie op het gebied van productieve woordenschat in te lopen op de sprekende kinderen. De resultaten van deze studie tonen aan dat een vroege interventie gericht op het kind, ouders en groepsleiding effectief is in het bevorderen van de receptieve en productieve taalontwikkeling van kleuters met een verstandelijke beperking.

In hoofdstuk 6 wordt de effectiviteit van de interventie uit hoofdstuk 5 verder onderzocht door middel van het vergelijken van de ontwikkeling van de 10 kinderen in de interventie met de ontwikkeling van een controlegroep van 18 kinderen die niet deelnamen aan de interventie. De resultaten lieten zien dat de kinderen in de interventiegroep een grotere ontwikkeling doormaakten op receptieve en productieve taalvaardigheden en non-verbaal IQ dan de kinderen in de controlegroep. Deze hogere leerwinst voor de interventiegroep werd voornamelijk bepaald door de niet-sprekende kinderen, aangezien zij een grotere ontwikkelingsgroei doormaakten dan de niet-sprekende kinderen in de controlegroep. Voor de sprekende kinderen was enkel een verschil in de ontwikkeling van taalbegrip tussen de interventie- en de controlegroep. Vervolgonderzoek van de kinderen in de interventiegroep één jaar na afloop van de interventie liet zien dat de ontwikkeling van de kinderen significant vertraagde. De resultaten van deze studie tonen dus aan dat een vroege taalinterventie de taalontwikkeling van kinderen met een verstandelijke beperking kan versnellen. De resultaten benadrukken echter het belang van voortzetting van de interventie voor een langere periode en in verschillende settings die achtereenvolgend het leren van kinderen stimuleren (zoals kinderdagverblijven en scholen), om zo de positieve leereffecten te behouden.

Het laatste hoofdstuk, hoofdstuk 7, beschrijft de bevindingen van de verschillende studies apart en integreert deze vervolgens in het licht van een neurocognitief model van taalverwerving en -verwerking (Hagoort, 2005). De algemene bevindingen zijn dat kinderen met een verstandelijke beperking een achterstand hebben in woordenschatontwikkeling die vergelijkbaar is met hun algehele ontwikkelingsniveau, maar dat ze specifieke beperkingen hebben in de ontwikkeling van fonologisch WG en syntactische vaardigheden. Daarbij bleken ouders van kinderen met een verstandelijke beperking hun niveau van communicatie en activiteiten aan te passen aan het ontwikkelingsniveau van hun kind, wat kan resulteren in interacties die minder stimulerend zijn voor de taalontwikkeling van het kind, aangezien op deze manier kinderen niet uitgedaagd worden om hogere taalniveaus te ontwikkelen. De communicatieve omgeving van kinderen met een verstandelijke beperking kan echter effectief worden afgestemd op de behoeften van deze kinderen door middel van een vroege interventie. Het stimuleren van de taalontwikkeling van kinderen door middel van woordenschatontwikkeling en de inzet van OC resulteerde in een significante ontwikkelingsgroei in kinderen met een verstandelijke beperking. Hoofdstuk 7 eindigt met suggesties voor vervolgonderzoek en implicaties voor de praktijk. Wat betreft de klinische implicaties wordt gesteld dat het belangrijk is dat vroege taalinterventies communicatieve competentie (een combinatie van sociale, strategische, operationele en linguïstische competentie) op een individuele manier benaderen, dat de interventie verder gericht is op de ontwikkeling van alle kerndomeinen die de taalontwikkeling beïnvloeden, dat de interventie onder andere OC, aanpassing van de omgeving, ouderbegeleiding en -instructie bevat en dat taalactiviteiten concreet, ervaringsgericht en betekenisvol zijn voor de kinderen, dat de interventie voor een langere periode wordt voortgezet en in verschillende situaties wordt ingezet (zoals thuisomgeving en kinderdagverblijf), om de kinderen zo te helpen met het generaliseren en overdragen van geleerde vaardigheden naar andere settings.

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# Curriculum Vitae

Margje van der Schuit is geboren op 4 april 1982 te Wageningen. Na het behalen van haar VWO-diploma aan het Pantarijn te Wageningen, begon zij in 2000 aan de opleiding Pedagogische Wetenschappen aan de Radboud Universiteit Nijmegen (RU). Als afstudeerrichting koos ze Orthopedagogiek: Leren & Ontwikkeling, met als specialisatie Zintuiglijke Handicaps. Tijdens haar studie werkte ze als student-assistent voor het vak Beschrijvende Statistiek. In 2005 rondde zij haar studie Orthopedagogiek af. Haar scriptie had betrekking op de functie van het magnosysteem bij het lezen. Begin 2006 startte zij met haar werkzaamheden als junioronderzoeker bij de sectie Orthopedagogiek: Leren & Ontwikkeling aan de RU. Tijdens haar promotietraject werkte zij tevens als docent bij de sectie Orthopedagogiek. Zo begeleidde ze verschillende masterstudenten bij hun scriptieonderzoek en begeleidde ze werkgroepen voor het vak Practicum Academische Vaardigheden. Na het afronden van haar proefschrift is ze in april 2011 begonnen als onderzoekster bij de afdeling PonTeM van Koninklijke Kentalis, een instelling voor zorg en onderwijs aan mensen met beperkingen in horen, zien en communicatie. Hier doet ze onderzoek onder de leerstoel Ondersteunde Communicatie (OC) bij meervoudige handicaps van prof. dr. Hans van Balkom. De onderzoekswerkzaamheden richten zich momenteel op de ontwikkeling van een video-home-trainingsprogramma voor ouders en hun kinderen met meervoudige beperkingen; en op de ontwikkeling van een digitale prentenboekentest voor het meten van woordenschatkennis en vertelvaardigheid van peuters en kleuters met meervoudige beperkingen.

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# Studies on Atypical Communication

*Ludo Verhoeven & Hans van Balkom (Editors)*

The aim of this series is to advance insight into the processes of communication within and across children and adults with special needs, including persons with learning disabilities, cognitive, physical and sensory impairments and persons from culturally and linguistically diverse backgrounds. It combines interest in sociolinguistic an psycholinguistic accounts of the acquisition and transmission of language and communication in these populations, and in educational solutions to help individuals overcome or reduce communication disabilities and to support their participation in society.

1. *Eliane Segers*, Multimedia Support of Language Learning in Kindergarten
2. *Loes Wauters*, Reading Comprehension in Deaf Children: The Impact of the Mode of Acquisition of Word Meanings
3. *Marjolijn van Weerdenburg,* Language and Literacy Development in Children with Specific Language Impairment
4. *Judit Steenge*, Bilingual Children with Specific Language Impairment: Additionally Disadvantaged?
5. *John van Daal*, Variation of Language, Cognition, and Behavior in Children with Specific Language Impairment
6. *Ellen Ormel*, Visual Word Recognition in Bilingual Deaf Children
7. *Marieke Peeters*, Emergent Literacy in Children with Cerebral Palsy
8. *Nina Davids*, Neurocognitive Markers of Phonological Processing: A Clinical Perspective
9. *Mieke Ketelaars*, The Nature of Pragmatic Language Impairment
10. *Margje van der Schuit*, Enhancing Early Language Development in Children with Intellectual Disabilities